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Review

A review of the reaction rates of uranium corrosion in water

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ABSTRACT

This work conducts a review on the kinetics of the uranium and water reaction system by gathering all available kinetic data and across a wide range of reaction conditions. Temperature and pressure dependent kinetic equations that describe the reaction are derived for the uraniumwater vapour and uranium-liquid water systems. Detailed tables which provide information about the reaction conditions and other parameters for each rate point are constructed. From evaluation of the tables, the effects of underlying parameters on the reaction kinetics are discussed. It is suggested that these parameters contribute to the reported discrepancies between reaction rate values under similar conditions. Better prediction of the corrosion rate and rate behaviour can be achieved by combining the kinetic rate equations with the effect of these underlying parameters.

1. Introduction

Predicting the kinetics of corrosion and degradation of metallic uranium in pure water is significant for the nuclear industry since it dictates the long-term performance of the metal, in the form of a spent nuclear fuel (SNF) or other, at any given environment. Proliferation and release of 'active' substances from an irradiated metal is, among other factors, directly correlated to corrosion degradation. Hence, corrosion performance is particularly important in a geological disposal facility (GDF) where SNF is permanently stored under moisture and oxygen-exhausted conditions but also in a reactor core where super-heated steam could leak through the cladding to react with the metal under high temperature (Hilton, 2000).

Unlike the reaction with oxygen, the reaction of metallic uranium with water generates hydrogen gas in addition to uranium oxide; following the reaction:

$$U + (2 + x)\, H_2O \rightarrow UO_{2+x} + (2+x)\, H_2 \quad (1)$$

With x obtaining values between 0 and 0.18 (Hilton, 2000; Sinkov et al., 2008; Baker et al., 1966; Colmenares, 1984; Colmenares et al., 1981; Haschke, 1998; Ritchie, 1981, 1984) and U_3O_8 (x = 0.67) transformation occurring between 250 °C and 275 °C. Hydrated oxides and scheopite mixtures have also been reported for reactions of high relative humidity (Rh) (Haschke, 1998; Kaminski, 2002; McEachern and Taylor, 1998; Waber et al., 1959; McNamara et al., 2002; Taylor et al., 1995).

When accumulated, hydrogen gas can become detrimental for the metal since it contributes to oxide/metal brittleness and under certain conditions can react directly with the metal to form uranium-hydride (UH_3) which is considered highly pyrophoric in air when in high mass and surface area (Banos et al., 2018a). This leads to more rapid degradation of the metal and results in a corrosion product potentially more prone to thermal transients (Banos et al., 2018a).

Under stoichiometric conditions Eq. (1) becomes the following:

$$U + 2\, H_2O \rightarrow UO_2 + 2\, H_2 \quad (2)$$

If H_2 reacts with the metal, UH_3 may form either as an intermediate (Kondo et al., 1974, 1964) or as a final reaction product (Baker et al., 1966; Colmenares, 1984; Allen et al., 1984; Danon et al., 1999; Waber, 1956) through Eq. (3):

$$2\, U + 3\, H_2 \rightarrow 2\, UH_3 \quad (3)$$

In this work, we revisit all the available literature data of uranium oxidation in liquid water and water vapour and generate useful formulas to describe the corrosion kinetics across a wide range of reaction conditions. In the literature, there have been a number of works that successfully conducted research on the kinetics of the uranium-water system (Hilton, 2000; Haschke, 1998; Ritchie, 1981, 1984; Pearce, 1989; Abrefah and Sell, 1999; Trimble, 1998). However, only the review work by Trimble (Trimble (1998)) reported both reaction rates and rate formulas across the whole temperature range (20–1440 °C). Still, no literature study provided detailed information on parameters affecting the reaction rate or reaction rate determination, other than pressure and temperature. Additionally, of these reviews the latest is dated to 2000 by Hilton et al. (Hilton, 2000) using reaction rate information provided by Trimble (Trimble (1998)) in 1998. In this

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present review, all available rate data have been revisited, reverified through the original documented sources while new reaction rate data from more recent works have also been integrated. In this review, unlike other works, it was attempted to provide a more detailed picture of the controls of the corrosion rates by more thoroughly capturing and contrasting the experimental parameters. This was achieved by collating information on parameters such as material provenance, heat-treatment, impurity content, surface preparation, method of measurement, relative humidity, open/closed system and others which are particularly important for influencing the reaction rates, their determination and the arising corrosion products. The effect of pressure and temperature on the system could be determined by plotting the available reaction rates. However, by providing more information about each reaction rate point, it is possible to identify the 'underlying' factors controlling how fast or slow corrosion/degradation progresses or explain discrepancies in reported rates under similar reaction conditions.

2. Clarifications – assumptions

In this section, we integrated some of the necessary assumptions that were made by the investigators when reporting the reaction rates along with clarifications about the manner that the rates were collected and processed.

Assumption 1. Linear oxidation was assumed for all surfaces. A completely clean surface is impossible to be sustained even under dynamic ultra-high vacuum (UHV) conditions (Allen et al., 1984; Allen and Tucker, 1973; Winer et al., 1987). For lightly oxidised surfaces, it is expected that the rate of further oxide growth will diminish as the oxide thickens. The rate of reaction is dictated by a thermal diffusion or charged particle migration process and, thus, is inversely proportional to the thickness. Arising stress owing to the difference in density between the metal (19.1 g/cm^3) and the forming oxide (10.97 g/cm^3) leads to a more porous and delaminated outer layer. Studies which observe active cracking and spallation often report an increase in the rate for a short time immediately after cracking, as fresh metal is exposed to the reactive species, then subsequently the rate starts to diminish again as newly forming oxide grows at the metal-oxide interface. This repeated cyclic process may be regarded as linear especially for long-term periods of corrosion.

Assumption 2. Wet corrosion was assumed to follow the stoichiometric conditions of Eq. 2. This assumption may be regarded as broad, especially for reaction conditions where UH_3 is forming either as an intermediate of as a final reaction product. For the weight-gain measurements, contribution of UH_3 production to the kinetics of the corrosion system is integrated to the final rate. This could lead to rate increase when the hydriding reaction is favoured and rate reduction when dehydriding conditions are evident. Weight gain measurements could lead to mis-estimation of the rate by solely assigning the change in mass to an oxide/metal mixture. Gas detection measurements would lead to underestimation of the rate since, aside from potential UH_3 development, not all hydrogen can escape into the gas phase (especially in the uranium-liquid water reaction - (Banos et al., 2019a,b)). Oxide thickness measurements would not provide reliable results if a hydride phase is misinterpreted to an oxide phase. The above limitations reveal the need to evaluate and compare the reported rates by always considering the experimental method of rate derivation.

Assumption 3. There is negligible surface area change of the uranium sample over time with progressive corrosion. In practice, the metallic surface area will decrease as the sample is corroding.

Assumption 4. There is negligible uranium transport/migration from the bulk metal to the reaction water. In practise, a recent study has shown that an increase in reactant's chloride content, acidity and temperature would lead to a considerable increase in uranium solubility in the fluid (Timofeev et al., 2018).

Two reaction rate tables were generated for the purposes of this work. The tables integrated 494 reaction rate points taken from 28 literature sources covering the uranium-water vapour reaction (T: 20–1440 °C). A further 182 reaction rate points from 19 literature sources for the uranium-liquid water reaction (T: 20.6–300 °C) were also collated. All data points were numbered in order to be easily traced when comparisons were made. Each reaction rate point was reverified wherever the original data source was available. Digitisation was employed in multiple occasions to retrieve data from graphs (Baker et al., 1966; Colmenares, 1984; Abrefah and Sell, 1999; Weirick, 1984). For a number of sources that were not available in the open literature, the data points were taken from Trimble (Trimble (1998)). The reaction rate was presented as milligrams of reacted uranium per unit area, per unit time (mgU. cm^{-2}. h^{-1}). Among other conversions that were made, a conversion factor of 7.4375 was used for data that were expressed as milligrams of weight gain per unit area, per unit time (mg. cm^{-2}. h^{-1}) which were the second most common reaction rate unit expression in the literature. SNF or irradiated fuel studies were included in the tables. To allow direct evaluation and comparisons between investigations in the literature, the following information were included in the tables next to the reaction rates:

1 **Uranium: water vapour:** Water vapour pressure (mbar), relative humidity (Rh %), material provenance, thermal treatment, surface cleaning preparation, impurity content (ppm), method of rate identification, open/closed system, UH_3 formation or not.
2 **Uranium: liquid water:** Reactant water type, material provenance, thermal treatment, surface cleaning preparation, impurity content (ppm), method of rate identification, open/closed system, UH_3 formation or not.

3. reaction rate data processing (reaction kinetics)

3.1. Arrhenius expression

For the oxidation reaction of uranium, the rate determining step is considered to be the anionic movement of the corrosive entities through the ubiquitous surface oxide, under the influence of an electric potential gradient. This process is expressed with an Arrhenius formula (Eq. 4) where the logarithm of the reaction rate constant is directly proportional to the inverse temperature, 1/T, with the constant of proportionality related to the activation energy (Q) of the reaction.

$$\boldsymbol{Lnk = ko - Q/RT} \quad (4)$$

Q is the activation energy of the reaction (kJ. mol^{-1}), T is the temperature of the reaction in K and R is the gas constant equal to 8.314 J.mol^{-1}. K^{-1}. In an Arrhenius plot of Lnk vs. 1/T, the activation energy can be calculated from the slope of the fitted line which equals to Q/R. After fitting the reaction rate data, the derived formulas for the various reaction regimes will be expressed by using Eq. 4 and the activation energies will be calculated.

3.2. The uranium: water-vapour reaction system

The rate of uranium corrosion in an anoxic water vapour environment is considered to be primarily affected by the temperature and water vapour pressure. Table A1 integrates all available data for the uranium and water vapour system. By processing the data of Table A1, and reviewing previous literature, the system was described across a wide temperature and pressure range. In the literature, a $P_{H2O}^{0.5}$ dependency was postulated for water vapour pressures up to 1013.25 mbar (Hilton, 2000; Sinkov et al., 2008; Baker et al., 1966; Colmenares et al., 1981; Trimble, 1998; Colby, 1966; Greenholt and Weirick, 1987; Harker, 2012; Orman et al., 1964; Ritchie et al., 1986).

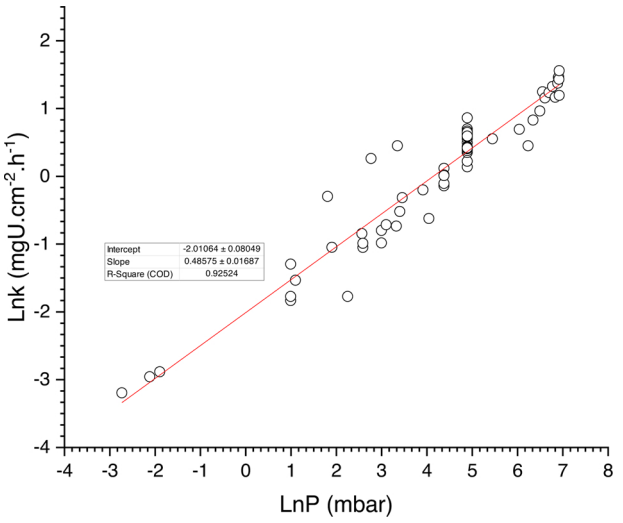

Fig. 1. LnP vs. Lnk plot for a temperature of 100 °C and P up to 1013.25 mbar. The reaction rate data included in this graph were retrieved from Table A. k represents the reaction rate of uranium corrosion and P represents the water vapour pressure of the system for values up to 1013.25 mbar. The slope of the fitted line yields the effect of water vapour pressure on the reaction.

Table 1
: The derived parameters from linear fitting of the LnP vs. Lnk plot for various temperatures.

Formula y = a x + b (y = lnk in mgU.cm^{-2}.h^{-1}, x = LnP in mbar)				
T (ºC)	**a**	**b**	**R^2**	**Comment**
40	0.84 ± 0.21	−6.53 ± 0.77	0.58	With Corcoran 1965 data
50	0.46 ± 0.07	−4.6 ± 0.28	0.83	Without Orman 1963, Baker 1966 data*
60	0.44 ± 0.09	−4.02 ± 0.39	0.67	–
70	0.46 ± 0.04	−3.67 ± 0.18	0.82	–
80	0.50 ± 0.03	−3.38 ± 0.11	0.93	Without Orman 1963, Baker 1966 and some of Kondo 1964 and Jackson 1977 data*
100	0.49 ± 0.02	−2.01 ± 0.08	0.93	–
150	0.44 ± 0.06	−0.81 ± 0.32	0.85	–
~200**	0.46 ± 0.17	0.32 ± 1.14	0.40	Without Wathen 1943 and Huddle 1953 data***

* Consistently higher reaction rates values were reported by these investigators but the same pressure effect (~0.5) was observed.

** 199, 200 and 201 °C.

*** Considerably higher reported rates were reported for these studies and they have been excluded.

The effect of water vapour pressure was studied by Trimble across a wide range of temperatures (Trimble, 1998). In this work, this analysis was performed again and the available data from Table A1 allowed analysis to be performed for the following temperatures: 40 °C, 50 °C, 60 °C, 70 °C, 80 °C, 100 °C, 150 °C and 200 °C. Above 200 °C, the corrosion studies were conducted under saturated or superheated conditions (P ≥ 1013.25 mbar or ≥ 1 atm) with insufficient data points to allow further investigation of the pressure effect for constant temperature. Fig. 1 represents the LnP vs. Lnk plot for T = 100 °C with the slope of the fitted line yielding the pressure coefficient which is the effect of pressure on the reaction. Table 1 integrates the parameters of the fitted lines for all analysed temperatures.

Except for the lowest reaction temperature analysed (40 °C) where the pressure coefficient was 0.84, the pressure dependency at all other temperatures ranged between 0.44 to 0.50. The correlation coefficient exhibited the lowest values at 40 °C and 200 °C. For the 40 °C, the low correlation coefficient allowed regression statistics to fit a 0.5 coefficient. The small temperature gradient (199–201 °C) between the processed data may have resulted in the low R^2 obtained for the 200 °C study. Based on the analysis of Table 1, it is plausible to evoke a $P^{0.5}$ effect for uranium-water vapour reaction and for pressures up to 1013.25 mbar.

By assuming that this observed pressure dependency holds across the entire pressure-temperature range, we normalised the reaction rate data to $P^{0.5}$ and plotted LnK vs. 1/T where:

$$\mathbf{K = k/P^{(n)}} \quad (5)$$

With n = 0.5, P representing the water vapour pressure in mbar, k the reaction rate in mgU.cm^{-2}. h^{-1} and 1/T the reciprocal temperature in K^{-1}. This plot is presented in Fig. 2. As already observed in (Trimble, 1998), the data show trend 'breaks' at ~ 300 °C and ~ 600 °C, with the data within this range yielding negligible effect on temperature (Fig. 2). It follows logically that the system should be divided into three temperature regimes to be described in greater detail. With regards to the lower temperature 'break', some investigators suggested that the 'threshold' over which the rates switch to negligible T-dependence is 250 °C (Haschke, 1998; Huddle, 1953), others set it to 295 °C (Trimble, 1998) or used data up to 300–302 °C to describe the low temperature regime (Hilton, 2000; Pearce, 1989; Abrefah and Sell, 1999). By considering the previous works and conducting multiple regression analyses on the data between 250 and 302 °C, a break for T < 300 °C was set. Only one rate value in the literature exceeded the typical pressure of 1013.25 mbar (Troutner (Troutner (1960)) – 225 °C, P = 13,789.5 mbar) for this lower temperature regime and was excluded from our calculations. A LnK vs. 1/T Arrhenius graph was plotted for T < 300 °C and P ≤ 1013.25 mbar (or ≤ 1 atm) and is presented in Fig. 3. Through linear regression the following equation has been derived:

$$LnK = 11.99–5396.8/T \quad (6)$$

For Q/R = 5396.8 and R = 8.314 J.mol^{-1}. K^{-1}, the activation energy (Q) calculated 44.9 kJ.mol^{-1}. Table 2 integrates all derived equations by previous investigations for comparison to be made with this work, taken from (Hilton, 2000; Haschke, 1998).

From the table, the rate formulas derived from Colmenares (Colmenares (1984)), Huddle (Huddle (1953)) and Haschke (Haschke (1998)) lead to high activation energies, while Ritchie's equation (Ritchie, 1984) yielded the lowest Q value at 37.7 kJ.mol^{-1} for T: 20–100 °C, P ≤ 1013.25. Good agreement can be observed between this work and the studies by Pearce (Pearce (1989)), Trimble (Trimble (1998)), Abrefah and Sell (Abrefah and Sell (1999)) and Hilton (Hilton (2000)).

Regarding the second temperature regime, the high temperature 'break' was set by some investigators at 500 °C (Haschke, 1998; Huddle, 1953), whilst, others used studies up to 579 °C (Trimble, 1998). It is notable that in the literature data there is a gap between 552 °C and 600 °C, which prevents us from narrowing down this temperature regime threshold. Linear regression analyses of various sets of data between 500 °C and 750 °C, allowed us to set the temperature break for T < 600 °C. Thus, the second temperature regime was set at 300 ≤ T < 600 °C. Within this range, Troutner (Troutner (1960)) used superheated steam at pressures above 1013.25 mbar (Table A1 – Reaction No. 311, 338, 339, 363–365, 382–384) and yielded considerably higher rate values (Fig. 2). Only one point by Pearce and Kay (Pearce and Kay (1987)) was below 1013.25 mbar with all remaining points derived at saturated conditions (1013.25 mbar). Regression analysis of the Lnk vs. 1/T plot for P =1013.25 mbar and 300 ≤ T < 600 °C yielded a very small positive dependence of the rate to the reciprocal temperature (1/T) (Fig. 4). It is important here to note that this graph presents no statistical significance owing to the considerably low R^2 (0.20). By assuming that this negligible temperature dependence is zero, the pressure effect on the rate could instead be determined. An LnP vs. Lnk plot for this temperature range was presented in Fig. 4. An 0.997 pressure dependence was derived from this plot (R^2 = 0.79). This

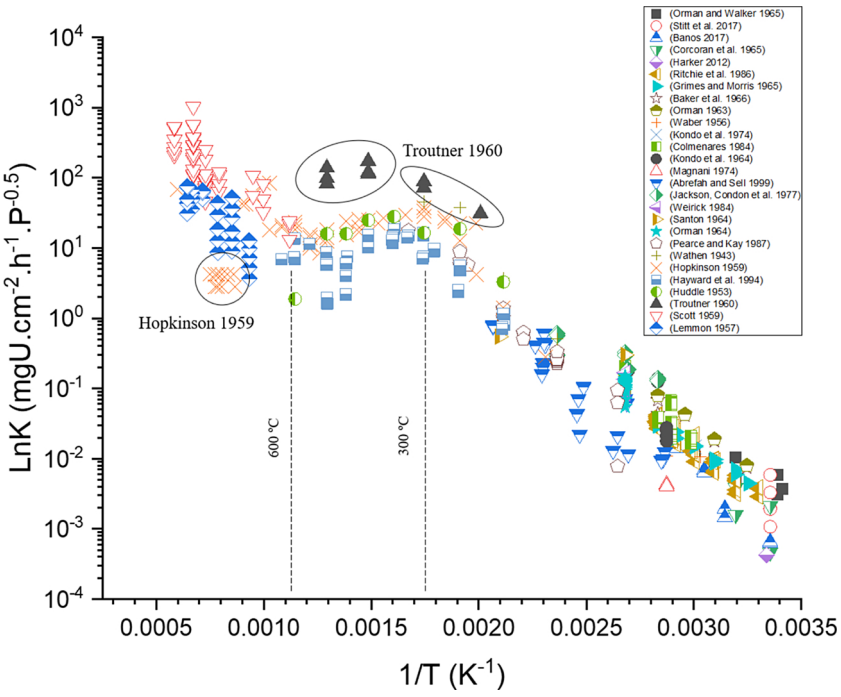

Fig. 2. Arrhenius plot of reaction rate literature data for uranium corrosion in water vapour (T: 20–1440 °C).

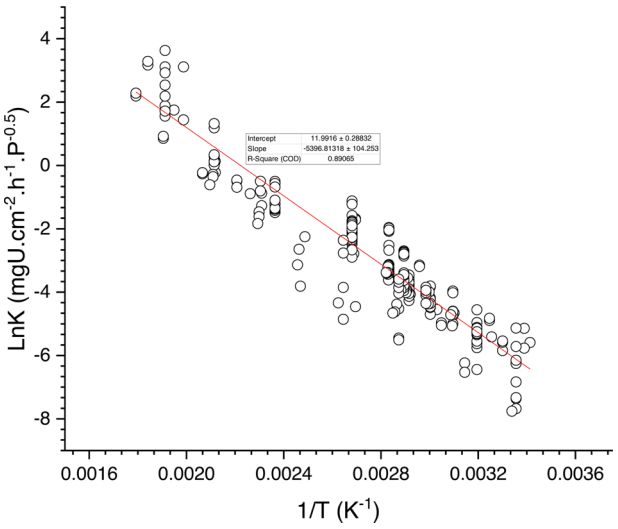

Fig. 3. Arrhenius plot for the reaction of uranium with water vapour at T < 300 °C and P ≤ 1013.25 mbar.

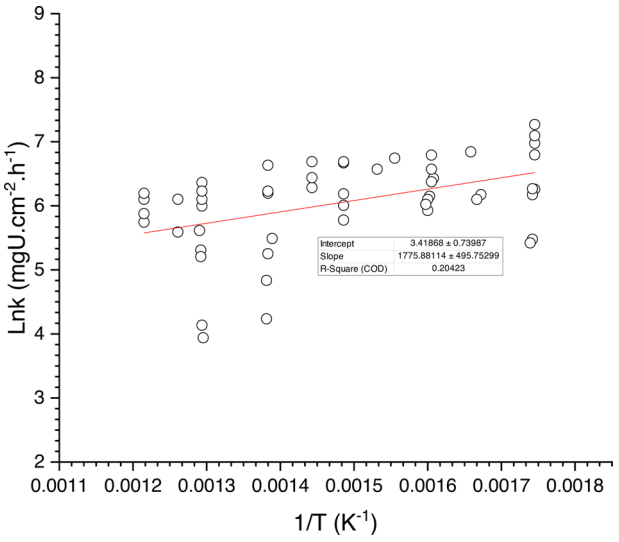

Fig. 4. Lnk vs. 1/T plot for 300 ≤ T < 600 °C. k represents the reaction rate of uranium corrosion. The slope of the fitted line yields a weak (negligible) positive effect of the reaction rate to the reciprocal T.

Table 2
Rate equation parameters for uranium oxidation in water vapour at the lower temperature regime.

Rate equation	Conditions	Activation energy Q (kJ. mol^{-1})	Reference
LnK = 10.64–7725/T	T < 100 °C, P < 1013.25	64.2	Colmenares 1984, Haschke 1998
LnK = 10.48–4534/T	T: 20–100 °C, P ≤ 1013.25	37.7	Ritchie 1984
LnK = 8.33–6860/T	T: 100–250 °C, P = 1013.25	57.0	Huddle 1953, Haschke 1998
LnK = 15.52–6675/T	T: 150 - 200 °C	55.5	Pearce and Kay 1987
LnK = 11.98–4943/T	T: 20–300 °C	41.1	Pearce 1989
LnK = 13.40–5472/T	T: 20 - 295 °C	45.5	Trimble 1998
LnK = 13.54–5472/T	T: 20–302 °C	45.5	Abrefah & Sell 1999
LnK = 13.79–5605/T	T: 20–302 °C, P ≤ 1013.25	46.6	Hilton 2000
LnK = 11.99–5397/T	T < 300 °C, P ≤ 1013.25	44.9	This work

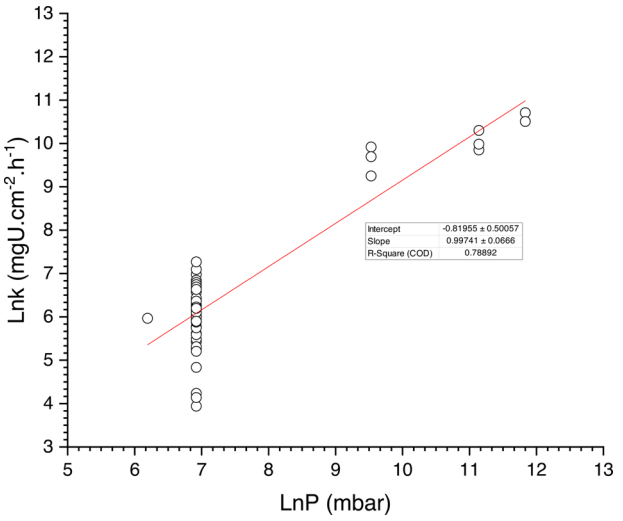

Fig. 5. LnP vs. Lnk plot for 300 ≤ T < 600 °C. k represents the reaction rate of uranium corrosion and P represents the water vapour pressure of the system. The slope of the fitted line yields the effect of water vapour pressure on the reaction.

dependence can only be representative for P > 1013.25 mbar since there is only one data point below 1 atm and a large scatter of rates for P = 1013.25. Since, only under this temperature regime the reaction rates are assumed to be independent to temperature and a P^1 effect is yielded for P > 1013.25 (Fig. 5), it is assumed that the inferred pressure effect is valid across the whole temperature range. The validity of such an assumption was tested for the single available point in the literature meeting the following conditions: T < 300 °C, P > 1013.25 mbar. From Table A1 (Reaction No. 311), a reaction rate of 3652 $mgU.cm^{-2}.h^{-1}$ for T = 225 °C, P = 13,789.5 mbar is reported from (Troutner (1960)). By using Eq. 6, for T = 225 °C (498 K) we find K = 3.168. By substituting the rate of the reaction and K to Eq. 5, n equals to 0.74.

For T ≥ 600 °C, two pressure systems may be observed one at 1013.25 mbar and the other 3447 mbar. No pressure effect can be derived owing to insufficiency of available data. By assuming square root dependence of pressure for P = 1013.25 mbar, an Arrhenius graph (LnK vs. 1/T) was plotted in Fig. 6. A number of rates derived by Hopkinson (Hopkinson (1959)) were 10–90 times lower than the rest of the

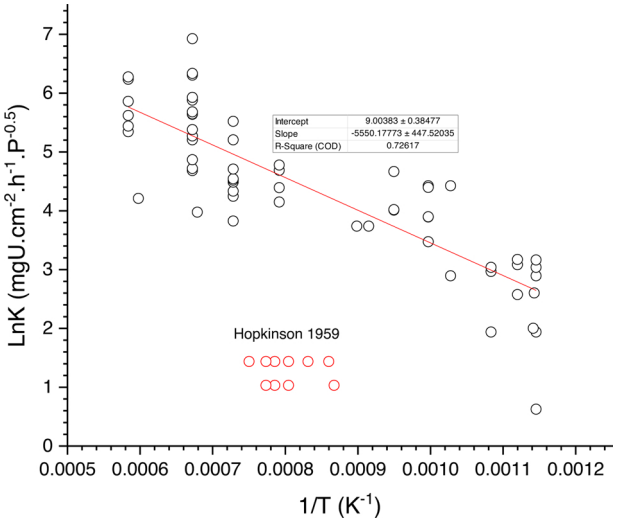

Fig. 6. Arrhenius plot for the reaction of uranium with water vapour at T ≥ 600 °C and P ≤ 1013.25 mbar. A number of data points by Hopkinson (1959) were considerably low and were excluded from the linear regression.

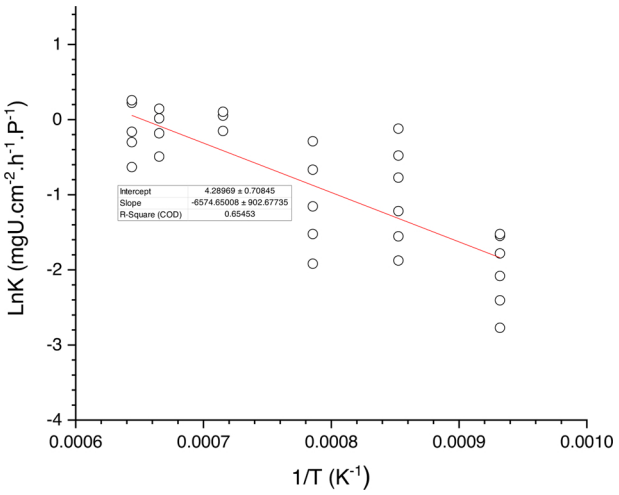

Fig. 7. Arrhenius plot for the reaction of uranium with water vapour at T ≥ 600 °C and P > 1013.25 mbar (P = 3447 mbar).

reported data (see Fig. 2 and 6) and were excluded from the linear regression study. The following equation has been derived from the graph:

$$LnK = 9.00–5550.2/T \quad (7)$$

With Q = 46.1 $kJ.mol^{-1}$. Trimble (Trimble (1998)) derived an activation energy of Q = 43.8 $kJ.mol^{-1}$, which is in agreement with this work.

At the high pressure regime (3447 mbar) studies by Lemmon (Lemmon (1957)) yielded consistently lower rates. Lemmon's reported rates were derived through H_2 detection studies which can lead to uncertainties especially in such a dynamic system (high pressure steam and H_2 gas). Linear regression of Lemmon's data is shown in Fig. 7. The derived equation was:

$$LnK = 4.29–6574.7/T \quad (8)$$

With K = k/P and Q = 54.7 $kJ.mol^{-1}$.

3.3. The uranium-liquid water system

For uranium corrosion under water-immersed conditions only the temperature is thought to affect the kinetics of the reaction if pure water is used. Since the mechanism of uranium oxidation is considered identical to that under water vapour, an Arrhenius plot (Lnk vs. 1/T) can be plotted to describe the kinetics (k in $mgU.cm^{-2}.h^{-1}$). Table A2 integrates 182 reaction rate points (T: 20.6–300 °C) from 19 literature sources. A reaction rate vs. 1/T plot of these data is displayed in Fig. 8. For non-purified conditions, the reactant water composition may greatly affect the reaction rate. By investigating and comparing the reported rates vs. reactant water composition (Table A2), it was possible to identify the following:

i O_2 saturated or O_2-containing reactant waters resulted in reduced reported rates.
ii The reaction rate was increased by lowering the pH value of the water, making it more acidic.
iii H_2-He-N_2 saturated water had negligible effect on the rate versus pure water.

Based on the above, three Arrhenius plots were produced, the first included all data corresponding to oxygenated water conditions, the second included all the remaining data from Table A2 and the third plot excluded all low/high pH studies from the anoxic water reactions.

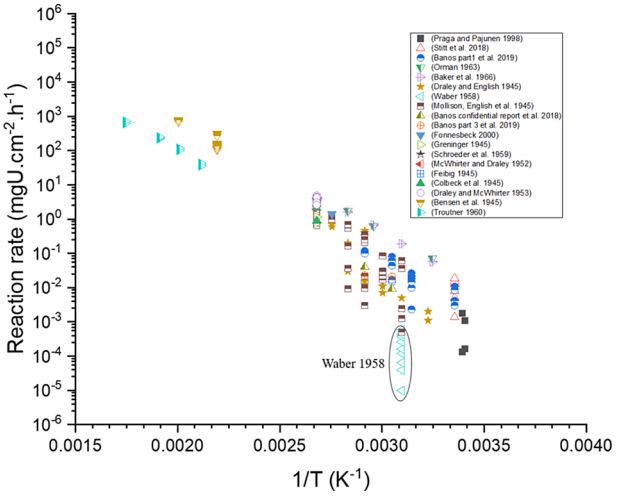

Fig. 8. Reaction rate vs. reciprocal T plot for the corrosion reaction of uranium with liquid water (T: 20.6–300 °).

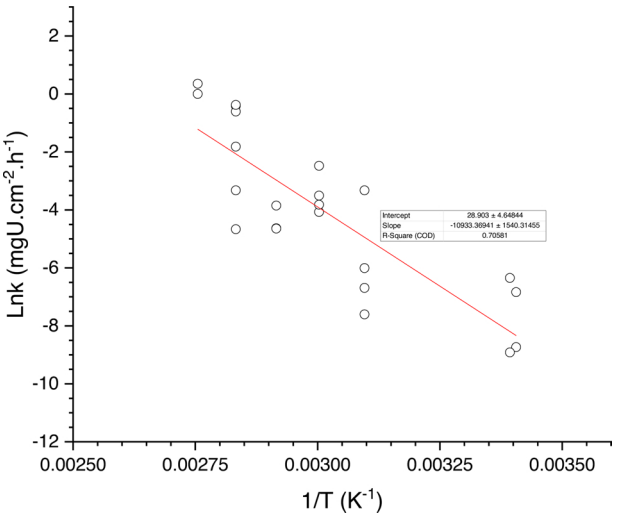

Fig. 9. An Arrhenius plot for the reaction of uranium with oxygen-containing liquid water.

3.3.1. *Kinetics of uranium corrosion with O_2-containing water*

A significant number of the reported rates from Table A2 were derived from studies where the reactant water was either (a) O_2-saturated (Mollison et al., 1945), (b) aerated (Mollison et al., 1945) or (c) test/simulated (oxygen containing) (Praga and Pajunen, 1998; Fonnesbeck, 2000). A clear diminishing effect of O_2 on the reaction rate may be observed from direct comparison of rates derived from oxygenated vs. deoxygenated water reactions (Table A2). All studies where oxygen was present in the reaction water were plotted in a Lnk vs. 1/T graph (Fig. 9). Oxygen saturated conditions are assumed for all the studies to allow comparison. Linear regression of the data yielded:

$$\text{Lnk} = 28.9 - 10933.4/T \quad (9)$$

with the calculated activation energy (Q) corresponding to 90.9 kJ.mol^{-1}.

Kinetics of uranium corrosion with oxygen-free water

The majority of studies used highly pure waters to study the uranium and water reaction system. Such a system may correlate to a real-world corrosion scenario when U-containing species corrode over prolonged periods with water under contained/trapped conditions. Under such conditions, dissolved oxygen is exhausted by corrosion, but

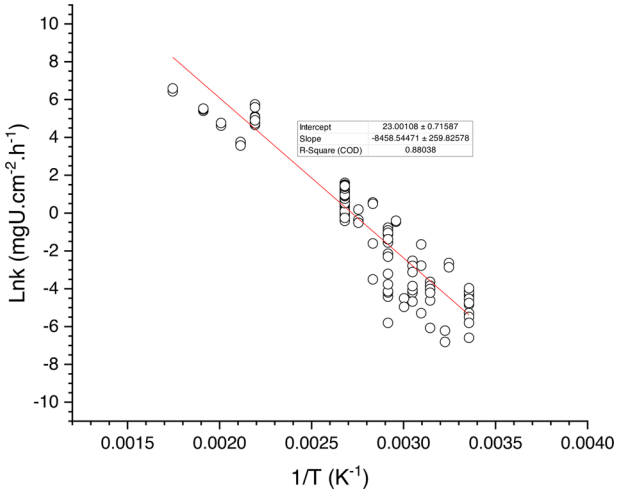

Fig. 10. Reaction rate vs. reciprocal T for the reaction of uranium with anoxic liquid water (T: 20.6–300 °C) and including varied water pH conditions.

significant amounts of water or moisture are still present. These corrosion conditions can be encountered in short/long-term storage plants such as ponds and silos. The data representing anoxic water corrosion conditions (Table A2) were plotted in an Arrhenius graph (Fig. 10). Here, it must be noted that the rate data by Waber (Waber (1958)) (collected from Trimble (Trimble (1998))) were excluded from our calculations since they were considerably low and did not fit the rest of the data. Linear regression of the data yielded:

$$\textit{Lnk} = 23.0 - 8458.5/T$$

with Q = 70.3 kJ.mol^{-1}. As will be discussed in a later section, pH variations somewhat affected the reaction rate. By excluding the data derived from studies with varied water pH the kinetic equation varied slightly as in Eq. 11:

$$\textit{Lnk} = 22.6 - 8282.6/T$$

With an Q of 68.9 kJ.mol^{-1}.

Table 3 integrates all derived equations by previous investigations for comparison to be made with this work. The data of this table were taken from (Hilton, 2000).

Aside from the activation energy for oxygenated waters, a good general agreement can be observed between this work and the literature studies. The kinetic equation of this study for oxygen-free water is particularly similar to that of Troutner (Troutner (1960)). The Q becomes even more comparable with the literature studies when the data reported for varied pH was excluded from the linear regression. However, Hilton's (Hilton, 2000), Trimble's (Trimble, 1998) and Burkart (Burkart (1956)) derived equations resulted in slightly lower activation energy values when compared to this work. For this work, this could be attributed to inclusion of data at 300 °C, or inclusion of data from more recent studies.

4. Effects on the rate or rate determination

Corrosion reactions and especially that of uranium with water, can be affected significantly by numerous factors other than just temperature or water vapour pressure. Parameters such as microstructure, impurity content, surface cleaning preparation, open/enclosed reaction system, reactant water etc. can affect the kinetics and even the corrosion behaviour of the system. Apart from the reaction rate, the reaction rate determination method may lead to inconsistencies between the 'real' vs. measured corrosion kinetics. All the above lead to notable discrepancies in the reported rates between investigators and groups for

Table 3
Integrating rate equation for uranium oxidation in liquid water.

Rate equation	Conditions	Comment	Activation energy Q (kJ. mol^{-1})	Reference
LnK = 22.21–7914/T	T: 60 - 343 °C	–	65.8	Burkart 1957
LnK = 23.02–8191/T	T: 50–350 °C	–	68.1	Troutner 1960
LnK = 22.64–8095/T	T > 300 °C	–	67.3	Trimble 1998
LnK = 22.34–7989/T	T > 300 °C	–	66.4	Hilton 2000
LnK = 23.0–8458.5/T	T: 20.6–300 °C	Oxygen-free waters with varied pH	70.3	This work
LnK = 22.6–8282.6/T	T: 20.6–300 °C	Oxygen-free waters without varied pH	68.9	This work
LnK = 28.9–10933.4/T	T: 20.6–300 °C	Oxygen-containing waters	90.9	This work

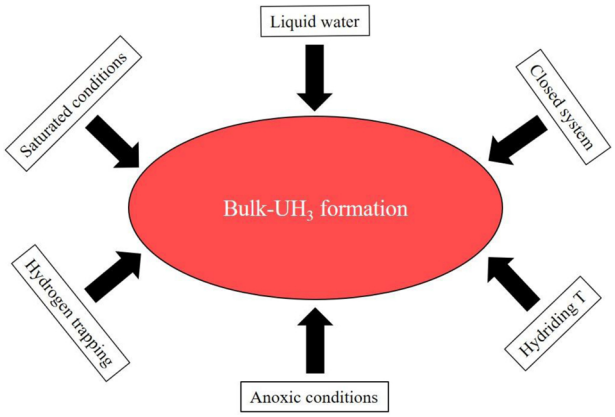

Fig. 11. Schematics showing the primary parameters leading to bulk-UH_3 formation facilitation.

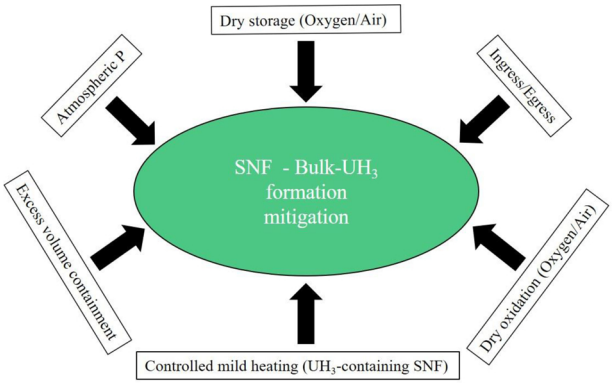

Fig. 12. Schematics showing parameters and conditions which can lead to bulk-UH_3 formation mitigation for spent nuclear fuel (SNF) under storage conditions. For UH_3-containing SNF the above conditions may lead to reduction of the persisting UH_3 quantities over time.

similar reaction conditions. Tables A and B have been compiled to provide a more in-depth comparison between different corrosion studies, shedding new light to the driving factors leading to these rate discrepancies. From Table A1 (U + $H_2O_{(g)}$), comparisons were only possible for systems with similar, if not identical, reaction temperature and pressure. On Table A2 (U + $H_2O_{(l)}$), the reactant water composition was the limiting factor apart from temperature. The affecting parameters will be discussed separately in the following sections.

4.1. Impurity content

The impurity level of the sample is among the most important parameters for affecting the rate of corrosion. High purity samples are more resistant to oxidation corrosion. This is clearly shown in the studies by Colmenares (Colmenares (1984)) (Table A1 – Reaction No. 107-130) where low purity samples (total impurity level = 457 ppm) exhibited 2–2.5 times higher reaction rates when compared to intermediate purity samples (total impurity level = 246 ppm). Similar behaviour is observed by the same investigator at 100 °C, by comparing intermediate and high purity samples (Table A1 – Reaction No. 222-243). It is important here to note that the effect of the total impurity content is not linearly related to the kinetics of the system since certain impurity entities will affect the kinetics differently and more considerably than others. For example Draley and McWhirter (Draley and McWhirter (1953)) working on the uranium-liquid water system also observed corrosion resistance improvement when metal purity was increased. From looking closely on the data derived from that study (Table A2 – Reaction No. 127-145), it is evident that corrosion was enhanced with higher carbon and iron contents, but reduced for high aluminium contents (Colmenares et al., 1981; Ritchie, 1981; Bennett et al., 1975).

4.2. Thermal pre-treatment

Thermal and mechanical sample treatment along with heat-treatment immediately after surface preparation and prior to corrosion may induce microstructural changes on the sample such as, grain growth (Burkart, 1956), stress-relief (Shamir et al., 2006; Tiferet et al., 2007), surface roughness, change in oxide stoichiometry, etc. Such surface modifications can greatly affect sample performance under oxidation and early hydriding corrosion (Banos et al., 2018b; Bloch and Mintz, 1990). Table A2 includes the data from an early study by Draley and McWhirter (Draley and McWhirter (1953)) working with corrosion of uranium in liquid water at 100 °C (Reaction No. 127-145). From that work, it is shown that higher temperature heating followed by water quenching leads to slower corrosion kinetics. Furnace cooling after heating, led to even more improved corrosion resistance for at least one corrosion event. Thermal heat-treatments and impurity content in the material are directly related since the former could drastically affect the distribution and retention of the latter in the metal, thus influencing the corrosion rate (Draley and McWhirter (1953)).

4.3. Surface cleaning preparation

Uranium oxidation kinetics also seem to be affected by the method of surface cleaning used for sample preparation prior to the reaction (Antill et al., 1976; Corcoran et al., 1965; Parlapanski, 1970), a factor which is also evident for early hydriding (Banos et al., 2016). From Table A1, this is observed in the low temperature studies (20–25 °C) and at 72.5 °C. Consistently higher reaction rates were reported when nitric acid etching was used to prepare the surfaces in comparison to mechanical abrading. This is evident for reactions in the same study (Table A1– Reaction No. 4-9), between different studies but with samples of same provenance (Table A1 – Reaction No. 4-11, (Stitt et al., 2017; Banos, 2017)) or between different studies but with uranium samples with similar impurity level (Table A1 - Reaction No. 1-13, (Corcoran et al., 1965; Stitt et al., 2017; Banos, 2017; Orman and Walker, 1965)). Colmenares (Colmenares (1984)), compared the reactions kinetics of samples prepared with electropolishing and mechanical abrasion by

using samples of the same provenance, under identical corrosion conditions (Table A1 – Reaction No. 107-130). Electropolishing led to samples exhibiting more resistance to corrosion. From Table A2, it was not possible to come to any useful conclusions since at least one parameter was different between studies, apart from surface preparation. Thus, it can be assumed that enhanced corrosion kinetics will be expected as we move from electropolishing to mechanical polishing to nitric acid etching.

4.4. Reactant water ($U + H_2O_{(l)}$)

As shown in the previous sections, the reaction rate for corrosion of U in liquid water is primarily affected by the composition of the reactant water and the temperature. Distilled and deionised water was used for the majority of studies (Table A2). For certain studies, aerated water of O_2-saturated water was used to simulate real-world conditions (Mollison et al., 1945; Praga and Pajunen, 1998; Fonnesbeck, 2000). Under such an environment, the kinetics of corrosion become slower owing to the poisoning effect of O_2 on the reaction (Fig. 9 - Eq. 9). For system where O_2 is not present, hydrogen begins to accumulate as a gaseous reaction product from oxidation and the water becomes saturated with dissolved hydrogen. Studies where the test water was saturated with H_2 (Mollison et al., 1945; McWhirter and Draley, 1952; Feibig, 1945; Colbeck and Spencer-Palmer, 1945) or other gases such as He or N_2 did not show any effect on the rate. Mollison and Draley (Mollison et al., 1945) introduced sodium chloride to the distilled water and confirmed that the rate almost halved with increasing concentration 1%–10 % and then 20 % (Table A2). Additionally, pH studies across a range of 9.2–6 showed that lowering the pH led to increased rate kinetics (Table A2 - Reaction No. 104-105, (Colbeck and Spencer-Palmer, 1945; Draley and English, 1945)).

4.5. Open vs. Enclosed system

As 'enclosed' is considered a system where H_2 gas is not 'swept' away but rather stays trapped in the near sample environment. In the real-world, scenarios include systems where hydrogen build-up is occurring unintentionally owing to shape or geometry of the sample or environment. Under favourable conditions, gaseous hydrogen may exceed a critical concentration in the vicinity of the metal and react to form UH_3 (Banos et al., 2018a). Apart from being unwanted, due to the very unstable nature of UH_3 in air, this reaction is more rapid than water oxidation once initiated and may lead to excessive consumption of uranium. In an 'open' reaction system, hydrogen is 'swept' away before pressure build-up occurs. This does not imply that UH_3 cannot be produced in such a system, especially for temperatures favouring hydriding corrosion (Banos et al., 2018a). Certainly, bulk-UH_3 formation is not facilitated as for an 'enclosed' system. Most experimental reaction rate determination methods assume that uranium dioxide is the only solid reaction product, according to Eq. 2. When UH_3 formation also occurs, this would lead to an overestimation of the oxidation rate if a weight change determination method is used and an underestimation of the rate if gas generation is utilized. From Table A1 (Reaction No. 43-47), significant discrepancy is reported between samples of similar history, purity level and reaction conditions but with differences in the corrosion system. Samples reacting in a sealed/ enclosed system (Baker et al., 1966; Orman and Walker, 1965; Orman, 1963) exhibited up to 3 times higher rates in comparison to those reacting in an open system (Ritchie et al., 1986). The slight difference in water vapour pressure between these studies is somewhat contributing but is not fully responsible for the discrepancy observed in the rates. Weirick et al. (Weirick, 1984) studied the kinetics of the reaction for very low pressures (2.7 mbar) at 100 °C and from their results (Table A1) it may be observed that the reaction rate was higher when the system was closed (periodically opened) in comparison to an opened system.

4.6. Method of reaction rate determination

As discussed in the previous section, for an assumed oxidation reaction according to Eq. 2 weight change studies may lead to overestimation of the rate if UH_3 is produced. On the other hand, studies relying on measuring hydrogen gas generation to determine rates would lead to an underestimation of the reported rate if UH_3 is formed. For this latter method, further underestimation may occur when the sample reacts under immersed conditions owing to hydrogen dissolution in water, especially if the relative volume of water is large. Weight gain measurements have the disadvantage of partial mass loss especially for temperature conditions where a powdery product is formed. Weight loss studies may be regarded as more reliable and is the most common rate determination method. However, error in the reported versus 'real' reaction rate may occur if the remainder and non-reacted metal is partially etched at the post-corrosion cleaning stage. Finally, oxide thickness measurements may introduce errors to the final rate owing to the heterogeneity of oxide growth across the sample surface. On Table A1 (20–25 °C), the reported rates of Orman et al. (Orman and Walker, 1965) (weight loss measurements) are consistently higher, even for lower temperature, than Stitt et al. (Stitt et al. (2017)) (oxide thickness measurements). At 75 °C, Magnani et al. (Magnani, 1974) using the H_2 gas generation method and an open system, reported rates up to 4 times lower than Kondo (Kondo et al., 1964) who used gravimetric studies for deriving the kinetics of the reaction.

4.7. UH_3 formation

The kinetics of the uranium-water reaction have been studied thoroughly and across a wide range of conditions by many prior studies (Tables A and B). However, most of the studies failed to address the possible formation (or not) of UH_3 as part of the reaction. This is predominantly due to many of these studies being conducted early in the 1940s and 1950s where there was either (a) no interest or knowledge of UH_3 being produced (or not) or (b) no method to detect its existence. At this time in history, only physical observation of the corroded surfaces could imply UH_3 growth (non-homogeneous pitting corrosion (Bensen et al., 1945)) though it could not be proved scientifically because necessary analytical techniques didn't exist. Later studies managed to verify its existence through measuring the difference between the experimental and theoretical H_2 production (Baker et al., 1966). Still, direct detection of UH_3 remains difficult since the hydride could be present either in an amorphous state and mixed with oxide or heterogeneously distributed as a bulk product under the oxide or could have formed as a transient intermediate product (Kondo et al., 1974, 1964; Fonnesbeck, 2000) enhancing the kinetics of the reaction. Recent studies (Banos et al., 2019a, b) employed X-ray diffraction (XRD) and secondary ion mass spectrometry (SIMS) to detect water-formed UH_3 but both of these analysis techniques were limited to finite corrosion layer thickness or finite sputtered surface. Post-corrosion sample degassing was one of the more reliable ways to indirectly verify and even quantify UH_3 in the corrosion products, even in an amorphous or mixed state (Danon et al., 1999; Banos et al., 2019a, b). Furthermore, studies where the duration of the reaction was very short (10 s of minutes (Schroeder et al., 1959)) may not provide the necessary time for H_2 to build-up in pressure and eventually react to form UH_3 (Banos et al., 2018a). Thus, reactions with the potential of UH_3 formation could have simply been stopped prior to this event. From all above, no information on UH_3 formation was provided by the majority of studies. From Table A1, UH_3 is first suggested to form as an intermediate by Kondo et al. (Kondo et al. (1964)). However, this work is not available in the literature and, thus, more detailed information about the reaction conditions for this formation are not accessible. Weirick et al. (Weirick, 1984) report UH_3 at 100 °C and very low pressure under contained/ enclosed conditions. For 'open' system studies where a carrier gas is used along with water vapour, UH_3 formation is reported at higher

temperatures and only when saturated water vapour conditions are achieved. Above 200 °C, almost all studies occur under saturated or superheated conditions and UH_3 is reported to form wherever characterisation was conceivable (Table A1– T: 200–500 °C). Between 250 °C and 500 °C, dehydriding kinetics become important reaching their maximum value at T ~ 500–550 °C. (Banos et al., 2018a). Thus, literature sources suggest that UH_3 existence for reaction systems above this temperature is improbable (Table A1 – T > 500 °C). In the uranium liquid system, the presence of UH_3 formation is indirectly verified through sample degassing for samples reacting under contained conditions even at 25 °C (Banos et al., 2019a, b). However, the quantity of accumulated hydride at these conditions is very small. Some early studies postulate no UH_3 even at 80 °C (Orman, 1963) while others suggest UH_3 forming as an intermediate product of uranium corrosion with simulated J13 well water at 90 °C (Fonnesbeck, 2000). At 100 °C, there is no information on UH_3 existence (or not) but the available data between 183 °C and 300 °C consistently report UH_3 in the reaction products. This is somewhat expected since these conditions lie within the temperature range where maximum hydriding rates are observed (Banos et al., 2018a). Hence, it seems probable that in many studies UH_3 may have formed in addition to UO_2 and its presence may have been overlooked, instead assuming that all corrosion was caused by the U + H_2O reaction.

5. Discussion

In the previous sections we derived the kinetics of uranium corrosion with water for various temperature and pressure regimes. The rate equations, and their derived parameters were compared to previous studies and showed good agreement (Tables 2 and 3). The main focus of this work was to gain more insight into the effects of certain parameters such as material history, thermal-treatment, surface preparation and the experimental method of rate determination. These 'background' parameters can affect the 'actual' reaction rate value and can contribute, if not fully account, for the observed discrepancies in the reported rates for similar temperature and pressure regimes. For example, in the uranium-water vapour system at 40 °C, Corcoran's (Colmenares, 1984) reported rates were considerably lower in comparison to the other investigators for similar vapour pressures (Table A1). It is believed that the method used to derive the rate (H_2 gas generation) played a primary role on the reported rate value. If weight change analysis had been employed on that study, then a reasonable expectation is that the rates would have been higher. The same effect was also observed in the U- $H_2O_{(l)}$ system and the studies by Banos et al. (Banos et al. (2019a)) (25–70 °C) which again used methods other than weight change, where the reported rates were consistently lower than other literature studies (Table A2). Especially for immersed experimental conditions, this is expected since H_2 cannot escape fully into the headspace but rather some hydrogen stays dissolved in water and/or trapped within the vicinity of the metal sample. Hydrogen trapping may be facilitated by the geometry of the cell and shape of sample. If a critical gas concentration threshold is surpassed, hydrogen can start to react with the metal as a uranium-hydrogen corrosion system leading to rate enhancement which is not represented in the gas generation data (underestimation of the rate). Thus, higher reaction rate values will be reported when an enclosed reaction system is monitored using a weight change method for rate determination (Table A1 - (Baker et al., 1966; Orman and Walker, 1965; Orman, 1963)) versus, an open system, where oxide thickness measurements are used for rate determination (Table A1 - (Ritchie et al., 1986; Grimes and Morris, 1965)). A different example is the considerably higher rates that were reported by Jackson and Condon (Jackson et al., 1977) for uranium oxidation with water vapour at 80 °C and 100 °C. This could be due to a combination of the mechanical treatment (shape), thermal treatment and surface cleaning preparation (nitric acid etching) of the sample (Table A1).

As derived from the data in Table A and Table A2, the formation of UH_3 in the reaction products is favoured in an enclosed versus an open system and in saturated versus non-saturated conditions. This is particularly evident from the data in Table A2 (uranium-liquid water system) where UH_3 is detected at environmental temperatures. The limited nature of the available literature information, in part due to its age, does not allow greater insight into the conditions under which UH_3 forms. It is highly probable that UH_3 did exist in studies where it is not reported or detected (amorphous state, mixed with oxide, etc.). Certainly, reaction rate enhancement owing to UH_3 formation may lead to notable discrepancies between studies especially in the range of 150–400 °C where hydriding kinetics are greatest. The schematic of Fig. 11 integrates the various driving factors which are critical in facilitating bulk-UH_3 formation under storage conditions or within a reactor core. Corrosion reaction scenarios which combine some these conditions have increased probability in forming bulk-UH_3 in their corrosion products.

6. Outlook and perspectives

This review presents a significant compilation of the literature on the kinetics of uranium corrosion in water. The study concentrates on the driving factors and parameters that may lead to rate enhancements and kinetic discrepancies, for similar reaction conditions, mainly through the formation of unstable uranium hydride – which is a feared and much maligned substance for the nuclear industry.

By thorough investigation of the published data, it is shown that when water is present, hydride formation is ubiquitous but not necessarily a bulk product of corrosion. A major pair of questions, which underpins safety concerns for any specific storage scenario is whether hydride has (i) formed in bulk quantities, and (ii) persisted without oxidation. This review has concluded that bulk hydride formation is only likely possible in wet storage environments where hydrogen cannot easily escape, and atmospheric oxygen cannot easily be replenished. Whilst wet storage has been the preferred approach for storing spent nuclear fuel for many decades, when considering the corrosion susceptibility of uranium metal in water and the pyrophoricity of its hydride, we would recommend dry storage as the preferred option.

Conceptually, if you have a storage system which does not contain free water, hydrogen or oxygen, then uranium corrosion cannot occur. In practice this is not so simple, since storage under a dry inert gas e.g. argon or even nitrogen requires sealing of the waste-form or facility. Any residual adsorbed waters are problematic in such a scenario. They will cause further reaction with residual metal until consumed, leading to hydrogen production. Because the system is sealed this is problematic as it will cause pressure build-up and potentially also bulk hydride formation.

Pragmatically, storage of metallic uranium under dry air in system which is not fully sealed for gas ingress and egress, is considered an acceptable and more cost-effective solution. It would have the benefit of significantly reducing the corrosion kinetics (not stopping it), whilst controlling the arising corrosion products to avoid the formation of the hydride.

For water-stored legacy wastes which may contain uranium hydride, we would also advocate a transition to such dry storage, which is being considered by Sellafield Ltd. in the UK. In this case, it is also worth considering whether waste drying might also be assisted by mild and controlled heating. This would potentially have the benefit of slowly and controllably eradicating both residual metal and hydride into a stable oxide mixture. Waste package design would need to include sufficient filtered ventilation to allow gas ingress/egress as well as internal structures to accommodate the arising volumetric expansion from conversion of uranium metal to oxide. If thermal treatment is conducted, then care must be given to control the heat flux. Whilst a recent study (Puranen et al., 2020) has successfully demonstrated thermal treatment of spent U metal fuel to form a stable oxide product,

their treatment temperatures were > 600 °C, which would have been sufficient to liberate residual volatile fission products. Instead, we would advocate slow heating and temperatures up to 200 °C. Schematics of Fig. 12 displays our suggested approach for storage of SNF. Bulk-hydride formation can be effectively mitigated under these conditions while existing UH_3-containing SNF parts could reduce their UH_3 quantities over time.

As a generalisation, based on the compilation of kinetic data it is acceptable to assume that any uranium metal stored in open air ponds is not expected to have formed any significant amount of bulk hydride, irrespective of the pond water chemistry. This we be applicable to sites like Sellafield in the UK and Hanford in the US (K-Basin). The only scenario where bulk hydride could form in an open system is where a localised hydrogen trap has formed in the vicinity of uranium metal. For example, two simple examples would include an upturned waste skip or a poorly sealed storage canister containing uranium metal. These types of scenario are not expected to be commonplace.

7. Conclusion

A review of the reported rates for the reaction of uranium with water has been conducted by gathering all available data from past literature. Useful formulas which describe the kinetics of the system have been derived for the various temperature and pressure regimes and were used to compare with pre-existing kinetic equations. Additional insight into the secondary parameters affecting the corrosion reaction kinetics, in addition to pressure and temperature have been provided indicating that material purity, preparation, experimental set-up and method of rate derivation are all important influences. It is suggested that these 'background' effects addressed here contribute to the reported rate discrepancies seen by similar studies. Most significant of all is the unwanted bulk-UH_3 formation which introduces uncertainty and unpredictability to the corrosion system. The various parameters and conditions that lead to bulk-UH_3 formation are provided along with the authors approach on mitigating bulk-UH_3 formation on SNF under storage conditions. Taking into consideration the effects of these parameters would allow better prediction of the kinetics and corrosion behaviour of uranium at any given condition and should form the basis for future studies to create enhanced predictive models for uranium corrosion.

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Appendix A

Table A1
Uranium - Water Vapour Reaction.

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
1	20	23.3	100	Unirradiated U rod or swarf	Mg-reduced/ Nitric-acid etched	Fe, Si, Al, C	Weight gain or loss	Closed	n/a	0.018	(Orman and Walker 1965)
2	22	26.4	100	Unirradiated U rod or swarf	Mg-reduced/ Nitric-acid etched	Fe, Si, Al, C	Weight gain or loss	Closed	n/a	0.016	(Orman and Walker 1965)
3	22	26.4	100	Unirradiated U rod or swarf	Mg-reduced/ Nitric-acid etched	Fe, Si, Al, C	Weight gain or loss	Closed	n/a	0.03	(Orman and Walker 1965)
4	25	31.6	100	Magnox natural U coupon	As-cast/ Mechanically polished (P600-2500 grade)	Fe, Al, C, N, O	Oxide thickness	Closed	No	0.00603	(Stitt et al. 2017)
5	25	31.6	100	Magnox natural U coupon	As-cast/ Mechanically polished (P600-2500 grade)	Fe, Al, C, N, O	Oxide thickness	Closed	No	0.01106	(Stitt et al. 2017)
6	25	31.6	100	Magnox natural U coupon	As-cast/ Mechanically polished (P600-2500 grade)	Fe, Al, C, N, O	Oxide thickness	Closed	No	0.03306	(Stitt et al. 2017)
7	25	31.6	100	Magnox natural U coupon	As-cast/Nitric acid etched	Fe, Al, C, N, O	Oxide thickness	Closed	No	0.01079	(Stitt et al. 2017)
8	25	31.6	100	Magnox natural U coupon	As-cast/Nitric acid etched	Fe, Al, C, N, O	Oxide thickness	Closed	No	0.01079	(Stitt et al. 2017)
9	25	31.6	100	Magnox natural U coupon	As-cast/Nitric acid etched	Fe, Al, C, N, O	Oxide thickness	Closed	No	0.01848	(Stitt et al. 2017)
10	25	31.6	100	Magnox natural U coupon	As-cast/ Mechanically polished (SiC P4000 grade)	Fe, Al, C, N, O	XRD fit	Closed	No	0.00357	(Banos 2017)

(*continued on next page*)

Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate ($mgU.cm^{-2}.h^{-1}$)	Reference
11	25	31.6	100	Magnox natural U coupon	As-cast/ Mechanically polished (SiC P4000 grade)	Fe, Al, C, N, O	Oxide thickness (SIMS)	Closed	No	0.00368	(Banos 2017)
12	25	31.6	100	Natural U discs/foils	Diamond polished	n/a	H_2 generation	Closed (800 mbar N_2)	n/a	0.0026	(Corcoran et al. 1965)
13	25	31.6	100	Natural U discs/foils	Nitric acid etched	n/a	H_2 generation	Closed (800 mbar N_2)	n/a	0.012	(Corcoran et al. 1965)
14	26.5	9.3	27	Depleted U square coupon	Mechanically polished	n/a	H_2 generation	Closed	n/a	0.0013	(Harker 2012)
15	30	12	28.5	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.01	(Ritchie et al. 1986)
16	30	23	54.3	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.018	(Ritchie et al. 1986)
17	30	31.7	75.1	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.022	(Ritchie et al. 1986)
18	34.2	26.7	50	Unirradiated U	n/a	n/a	Oxide thickness (Interferometry)	n/a	n/a	0.023	(Grimes and Morris 1965)
19	35	56.1	100	Unirradiated natural U rod	Mg-reduced/ Nitric-acid etched	Fe, Si, Al, C	H_2 generation/ Weight gain	Closed	n/a	0.056	(Baker and Less et al. 1966)
20	35	56.1	100	Unirradiated U rod	Mg-reduced/ Nitric-acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	No	0.06	(Orman 1963)
21	40	12.1	16.4	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.011	(Ritchie et al. 1986)
22	40	13.1	17.8	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.013	(Ritchie et al. 1986)
23	40	23.6	32	Unirradiated U	n/a	n/a	Oxide thickness (Interferometry)	n/a	n/a	0.034	(Grimes and Morris 1965)
24	40	26.7	36.3	Unirradiated U	n/a	n/a	Oxide thickness (Interferometry)	n/a	n/a	0.031	(Grimes and Morris 1965)
25	40	28.3	38.5	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.031	(Ritchie et al. 1986)
26	40	32	43.5	Natural U discs/foils	Nitric acid etched	n/a	H_2 generation	Closed (800 mbar N_2)	n/a	0.009	(Corcoran et al. 1965)
27	40	32	43.5	Natural U discs/foils	Nitric acid etched	n/a	H_2 generation	Closed (800 mbar N_2)	n/a	0.022	(Corcoran et al. 1965)
28	40	42.3	57.5	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.031	(Ritchie et al. 1986)
29	40	42.3	57.5	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.032	(Ritchie et al. 1986)
30	40	42.3	57.5	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.034	(Ritchie et al. 1986)
31	40	55.3	75.1	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.037	(Ritchie et al. 1986)
32	40	73.6	100	Unirradiated U rod or swarf	Mg-reduced/ Nitric-acid etched	Fe, Si, Al, C	Weight gain or loss	Closed	n/a	0.045	(Orman and Walker 1965)
33	40	73.6	100	Unirradiated U rod or swarf	Mg-reduced/ Nitric-acid etched	Fe, Si, Al, C	Weight gain or loss	Closed	n/a	0.09	(Orman and Walker 1965)
34	45	31.6	33.1	Magnox natural U coupon	As-cast/ Mechanically polished (SiC P4000 grade)	Fe, Al, C, N, O	XRD fit	Closed	No	0.011	(Banos 2017)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
35	45	31.6	33.1	Magnox natural U coupon	As-cast/ Mechanically polished (SiC P4000 grade)	Fe, Al, C, N, O	Oxide thickness (SIMS)	Closed	No	0.0082	(Banos 2017)
36	49.5	12.2	10.2	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.033	(Ritchie et al. 1986)
37	50	12.2	9.9	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.035	(Ritchie et al. 1986)
38	50	26.5	21.5	Unirradiated U	n/a	n/a	Oxide thickness (Interferometry)	n/a	n/a	0.045	(Grimes and Morris 1965)
39	50	26.5	21.5	Unirradiated U	n/a	n/a	Oxide thickness (Interferometry)	n/a	n/a	0.05	(Grimes and Morris 1965)
40	50	43.1	35	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.0587	(Ritchie et al. 1986)
41	50	73.6	59.8	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.0742	(Ritchie et al. 1986)
42	50	76.8	62.4	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.086	(Ritchie et al. 1986)
43	50	93.7	76.1	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.065	(Ritchie et al. 1986)
44	50	123.1	100	Unirradiated U rod or swarf	Mg-reduced/ Nitric-acid etched	Fe, Si, Al, C	Weight gain or loss	Closed	n/a	0.1	(Orman and Walker 1965)
45	50	123.1	100	Unirradiated U rod or swarf	Mg-reduced/ Nitric-acid etched	Fe, Si, Al, C	Weight gain or loss	Closed	n/a	0.11	(Orman and Walker 1965)
46	50	123.1	100	Unirradiated natural U rod	Mg-reduced/ Nitric-acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	No	0.21	(Orman 1963)
47	50	123.1	100	Unirradiated U rod	Mg-reduced/ Nitric-acid etched	Fe, Si, Al, C	H_2 generation/ Weight gain	Closed	n/a	0.199	(Baker and Less et al. 1966)
48	50.3	42.6	34.1	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.0412	(Ritchie et al. 1986)
49	50.9	44.5	34.6	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.0596	(Ritchie et al. 1986)
50	55	31.6	20.1	Magnox natural U coupon	As-cast/ Mechanically polished (SiC P4000 grade)	Fe, Al, C, N, O	XRD fit	Closed	No	0.039	(Banos 2017)
51	55	31.6	20.1	Magnox natural U coupon	As-cast/ Mechanically polished (SiC P4000 grade)	Fe, Al, C, N, O	Oxide thickness (SIMS)	Closed	No	0.036	(Banos 2017)
52	57	17.3	10	Natural-U	Cold-rolled sheet	n/a	n/a	n/a	n/a	0.044	(Waber 1956)
53	60	12.5	6.3	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.0763	(Ritchie et al. 1986)
54	60	23.8	12	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.0637	(Ritchie et al. 1986)
55	60	26.8	13.5	Unirradiated U	n/a	n/a	Oxide thickness (Interferometry)	n/a	n/a	0.077	(Grimes and Morris 1965)
56	60	26.8	13.5	Unirradiated U	n/a	n/a	Oxide thickness (Interferometry)	n/a	n/a	0.079	(Grimes and Morris 1965)
57	60	31.8	16	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.0639	(Ritchie et al. 1986)
58	60	74.3	37.4	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.0783	(Ritchie et al. 1986)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
59	60	76.7	38.6	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.0987	(Ritchie et al. 1986)
60	60	96.2	48.4	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.111	(Ritchie et al. 1986)
61	60	110.3	55.5	n/a	n/a	n/a	Volumetric, gravimetric, barometric studies and gas chromatography	Closed	Intermediate***	0.154	(Kondo et al. 1974)
62	60	123	61.9	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.246	(Ritchie et al. 1986)
63	60	126.8	63.8	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.13	(Ritchie et al. 1986)
64	60	198.7	100	Unirradiated U rod or swarf	Mg-reduced/ Nitric-acid etched	Fe, Si, Al, C	Weight gain or loss	Closed	n/a	0.18	(Orman and Walker 1965)
65	60.5	124.5	61.2	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.205	(Ritchie et al. 1986)
66	60.9	42.2	20.4	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.082	(Ritchie et al. 1986)
67	62	79.7	36.6	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.148	(Colmenares 1984)
68	62	79.7	36.6	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.167	(Colmenares 1984)
69	62	79.7	36.6	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.161	(Colmenares 1984)
70	62	79.7	36.6	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.172	(Colmenares 1984)
71	62	79.7	36.6	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.190	(Colmenares 1984)
72	62	79.7	36.6	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.173	(Colmenares 1984)
73	62	155.6	71.4	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.16	(Ritchie et al. 1986)
74	65	249.5	100	Unirradiated U rod	Mg-reduced/ Nitric-acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	No	0.679	(Orman 1963)
75	65	249.5	100	Unirradiated U rod	Mg-reduced/ Nitric-acid etched	Fe, Si, Al, C	H_2 generation/ Weight gain	Closed	n/a	0.65	(Baker and Less et al. 1966)
76	69.4	120.0	39.6	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.186	(Ritchie et al. 1986)
77	70	12.4	4.0	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.093	(Ritchie et al. 1986)
78	70	23.3	7.5	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.130	(Ritchie et al. 1986)
79	70	23.6	7.6	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.124	(Ritchie et al. 1986)
80	70	24.9	8.0	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.111	(Ritchie et al. 1986)
81	70	26.4	8.5	Unirradiated U	n/a	n/a	Oxide thickness (Interferometry)	n/a	n/a	0.1	(Grimes and Morris 1965)
82	70	26.4	8.5	Unirradiated U	n/a	n/a	Oxide thickness (Interferometry)	n/a	n/a	0.124	(Grimes and Morris 1965)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
83	70	31.6	10.2	Magnox natural U coupon	As-cast/ Mechanically polished (SiC P4000 grade)	Fe, Al, C, N, O	XRD fit	Closed	No	0.079	(Banos 2017)
84	70	42.3	13.6	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.122	(Ritchie et al. 1986)
85	70	42.9	13.8	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.144	(Ritchie et al. 1986)
86	70	56.3	18.1	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.155	(Ritchie et al. 1986)
87	70	57.2	18.4	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.165	(Ritchie et al. 1986)
88	70	57.2	18.4	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.216	(Ritchie et al. 1986)
89	70	74.0	23.8	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.138	(Ritchie et al. 1986)
90	70	74.6	24.0	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.196	(Ritchie et al. 1986)
91	70	74.6	24.0	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.206	(Ritchie et al. 1986)
92	70	77.7	25.0	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.18	(Ritchie et al. 1986)
93	70	96.1	30.9	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.227	(Ritchie et al. 1986)
94	70	97.3	31.3	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.196	(Ritchie et al. 1986)
95	70	123.1	39.6	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.247	(Ritchie et al. 1986)
96	70	123.7	39.8	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.35	(Ritchie et al. 1986)
97	70	124.4	40.0	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.277	(Ritchie et al. 1986)
98	70	158.6	51.0	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.247	(Ritchie et al. 1986)
99	70	198.0	63.7	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.35	(Ritchie et al. 1986)
100	70	202.4	65.1	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.289	(Ritchie et al. 1986)
101	70	310.9	100	Unirradiated natural U rod or swarf	Mg-reduced/ Nitric acid etched	Fe, Si, Al, C	Weight gain or loss	Closed	n/a	0.31	(Orman and Walker 1965)
102	70	310.9	100	Unirradiated natural U rod or swarf	Mg-reduced/ Nitric acid etched	C, Fe, Si, Al	Weight loss	Closed	n/a	0.31	(Orman and Walker 1965)
103	70.6	204.2	64.0	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.412	(Ritchie et al. 1986)
104	70.9	44.6	13.8	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.13	(Ritchie et al. 1986)
105	71.2	127.35	38.9	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.214	(Ritchie et al. 1986)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
106	71.4	239.7	72.6	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.279	(Ritchie et al. 1986)
107	72.5	133	38.4	Depleted- U	α-annealed/ Mechanically polished	Low purity - Total 457 (C: 31, Al: 5, Si: 15, Mn: 45, Fe: 142, W < 100, P < 100, Cu:11)	Weight gain	Static/ Closed	n/a	0.660	(Colmenares 1984)
108	72.5	133	38.4	Depleted- U	α-annealed/ Mechanically polished	Low purity - Total 457 (C: 31, Al: 5, Si: 15, Mn: 45, Fe: 142, W < 100, P < 100, Cu:11)	Weight gain	Static/ Closed	n/a	0.696	(Colmenares 1984)
109	72.5	133	38.4	Depleted- U	α-annealed/ Mechanically polished	Low purity - Total 457 (C: 31, Al: 5, Si: 15, Mn: 45, Fe: 142, W < 100, P < 100, Cu:11)	Weight gain	Static/ Closed	n/a	0.750	(Colmenares 1984)
110	72.5	133	38.4	Depleted- U	α-annealed/ Mechanically polished	Low purity - Total 457 (C: 31, Al: 5, Si: 15, Mn: 45, Fe: 142, W < 100, P < 100, Cu:11)	Weight gain	Static/ Closed	n/a	0.777	(Colmenares 1984)
111	72.5	133	38.4	Depleted- U	α-annealed/ Mechanically polished	Low purity - Total 457 (C: 31, Al: 5, Si: 15, Mn: 45, Fe: 142, W < 100, P < 100, Cu:11)	Weight gain	Static/ Closed	n/a	0.739	(Colmenares 1984)
112	72.5	133	38.4	Depleted- U	α-annealed/ Mechanically polished	Low purity - Total 457 (C: 31, Al: 5, Si: 15, Mn: 45, Fe: 142, W < 100, P < 100, Cu:11)	Weight gain	Static/ Closed	n/a	0.750	(Colmenares 1984)
113	72.5	133	38.4	Depleted- U	α-annealed/ Mechanically polished	Low purity - Total 457 (C: 31, Al: 5, Si: 15, Mn: 45, Fe: 142, W < 100, P < 100, Cu:11)	Weight gain	Static/ Closed	n/a	0.735	(Colmenares 1984)
114	72.5	133	38.4	Depleted- U	α-annealed/ Mechanically polished	Low purity - Total 457 (C: 31, Al: 5, Si: 15, Mn: 45, Fe: 142, W < 100, P < 100, Cu:11)	Weight gain	Static/ Closed	n/a	0.706	(Colmenares 1984)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
115	72.5	133	38.4	Depleted- U	α-annealed/ Mechanically polished	Low purity - Total 457 (C: 31, Al: 5, Si: 15, Mn: 45, Fe: 142, W < 100, P < 100, Cu:11)	Weight gain	Static/ Closed	n/a	0.701	(Colmenares 1984)
116	72.5	133	38.4	Depleted- U	α-annealed/ Mechanically polished	Intermediate purity – Total: 246 (Fe: 60, Mn: 70, Cu: 20, Si: 20, Al: 40)	Weight gain	Static/ Closed	n/a	0.303	(Colmenares 1984)
117	72.5	133	38.4	Depleted- U	α-annealed/ Mechanically polished	Intermediate purity – Total: 246 (Fe: 60, Mn: 70, Cu: 20, Si: 20, Al: 40)	Weight gain	Static/ Closed	n/a	0.319	(Colmenares 1984)
118	72.5	133	38.4	Depleted- U	α-annealed/ Mechanically polished	Intermediate purity – Total: 246 (Fe: 60, Mn: 70, Cu: 20, Si: 20, Al: 40)	Weight gain	Static/ Closed	n/a	0.306	(Colmenares 1984)
119	72.5	133	38.4	Depleted- U	α-annealed/ Mechanically polished	Intermediate purity – Total: 246 (Fe: 60, Mn: 70, Cu: 20, Si: 20, Al: 40)	Weight gain	Static/ Closed	n/a	0.320	(Colmenares 1984)
120	72.5	133	38.4	Depleted- U	α-annealed/ Mechanically polished	Intermediate purity – Total: 246 (Fe: 60, Mn: 70, Cu: 20, Si: 20, Al: 40)	Weight gain	Static/ Closed	n/a	0.354	(Colmenares 1984)
121	72.5	133	38.4	Depleted- U	α-annealed/ Mechanically polished	Intermediate purity – Total: 246 (Fe: 60, Mn: 70, Cu: 20, Si: 20, Al: 40)	Weight gain	Static/ Closed	n/a	0.387	(Colmenares 1984)
122	72.5	133	38.4	Depleted- U	Electropolished	Intermediate purity – Total: 246 (Fe: 60, Mn: 70, Cu: 20, Si: 20, Al: 40)	Weight gain	Static/ Closed	n/a	0.227	(Colmenares 1984)
123	72.5	133	38.4	Depleted- U	Electropolished	Intermediate purity – Total: 246 (Fe: 60, Mn: 70, Cu: 20, Si: 20, Al: 40)	Weight gain	Static/ Closed	n/a	0.222	(Colmenares 1984)
124	72.5	133	38.4	Depleted- U	Electropolished	Intermediate purity – Total: 246 (Fe: 60, Mn: 70, Cu: 20, Si: 20, Al: 40)	Weight gain	Static/ Closed	n/a	0.245	(Colmenares 1984)
125	72.5	133	38.4	Depleted- U	Electropolished	Intermediate purity – Total: 246 (Fe: 60, Mn: 70, Cu: 20, Si: 20, Al: 40)	Weight gain	Static/ Closed	n/a	0.243	(Colmenares 1984)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
126	72.5	133	38.4	Depleted- U	Electropolished	Intermediate purity – Total: 246 (Fe: 60, Mn: 70, Cu: 20, Si: 20, Al: 40)	Weight gain	Static/ Closed	n/a	0.260	(Colmenares 1984)
127	72.5	133	38.4	Depleted- U	Electropolished	Intermediate purity – Total: 246 (Fe: 60, Mn: 70, Cu: 20, Si: 20, Al: 40)	Weight gain	Static/ Closed	n/a	0.306	(Colmenares 1984)
128	72.5	133	38.4	Depleted- U	Electropolished	Intermediate purity – Total: 246 (Fe: 60, Mn: 70, Cu: 20, Si: 20, Al: 40)	Weight gain	Static/ Closed	n/a	0.357	(Colmenares 1984)
129	72.5	133	38.4	Depleted- U	Electropolished	Intermediate purity – Total: 246 (Fe: 60, Mn: 70, Cu: 20, Si: 20, Al: 40)	Weight gain	Static/ Closed	n/a	0.367	(Colmenares 1984)
130	72.5	133	38.4	Depleted- U	Electropolished	Intermediate purity – Total: 246 (Fe: 60, Mn: 70, Cu: 20, Si: 20, Al: 40)	Weight gain	Static/ Closed	n/a	0.366	(Colmenares 1984)
131	74	368.8	100	Unirradiated natural U rod or swarf	Mg-reduced/ Nitric acid etched	Fe, Si, Al, C	Weight gain or loss	Closed	n/a	0.38	(Orman and Walker 1965)
132	74	368.8	100	Unirradiated natural U rod or swarf	Mg-reduced/ Nitric acid etched	Fe, Si, Al, C	Weight gain or loss	Closed	n/a	0.38	(Orman and Walker 1965)
133	75	42.3	11	n/a	n/a	n/a	Volumetric, gravimetric, barometric studies and gas chromatography	Closed	Intermediate***	0.168	(Kondo et al. 1964)
134	75	53.9	14	n/a	n/a	n/a	Volumetric, gravimetric, barometric studies and gas chromatography	Closed	Intermediate***	0.13	(Kondo et al. 1964)
135	75	80.8	21	n/a	n/a	n/a	Volumetric, gravimetric, barometric studies and gas chromatography	Closed	Intermediate***	0.19	(Kondo et al. 1964)
136	75	107.7	28	n/a	n/a	n/a	Volumetric, gravimetric, barometric studies and gas chromatography	Closed	Intermediate***	0.26	(Kondo et al. 1964)
137	75	134.6	35	n/a	n/a	n/a	Volumetric, gravimetric, barometric studies and gas chromatography	Closed	Intermediate***	0.32	(Kondo et al. 1964)
138	75	192.4	50	Natural-U	Cold-rolled sheet	n/a	n/a	n/a	n/a	0.15	(Waber 1956)
139	75	384.7	100	Unirradiated natural U	Quenched from γ-phase	n/a	H_2 generation	Open (N_2 carrier gas)	n/a	0.084	(Magnani 1974)
140	75	384.7	100	Unirradiated natural U	Quenched from γ-phase	n/a	H_2 generation	Open (N_2 carrier gas)	n/a	0.084	(Magnani 1974)
141	75	384.7	100	Unirradiated natural U	Quenched from γ-phase	n/a	H_2 generation	Open (N_2 carrier gas)	n/a	0.0793	(Magnani 1974)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
142	76	72	18.0	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He- H2O gas stream)	No	0.106*	(Abrefah and Sell 1999)
143	77	65	15.5	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He- H2O gas stream)	No	0.079*	(Abrefah and Sell 1999)
144	78	63	14.5	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He- H2O gas stream)	No	0.075*	(Abrefah and Sell 1999)
145	80	3.8	0.8	Unirradiated natural U rolled foil shaped into concave discs	α-annealed, β- quench/ Nitric acid etched	C: 98, Fe: 85, Si: 60, Al: 38, N: 10, O < < 100	Weight gain	Open (Ar gas stream)	No	0.274	(Jackson et al. 1977)
146	80	3.8	0.8	Unirradiated natural U rolled foil shaped into concave discs	α-annealed, γ- quenched/ Nitric acid etched	C: 98, Fe: 85, Si: 60, Al: 38, N: 10, O < < 100	Weight gain	Open (Ar gas stream)	No	0.252	(Jackson et al. 1977)
147	80	4.0	0.8	n/a	n/a	n/a	Volumetric, gravimetric, barometric studies and gas chromatography	Closed	Intermediate***	0.25	(Kondo et al. 1964)
148	80	15.9	3.4	n/a	n/a	n/a	Volumetric, gravimetric, barometric studies and gas chromatography	Closed	Intermediate***	0.55	(Kondo et al. 1964)
149	80	15.9	3.4	Unirradiated natural U rolled foil shaped into concave discs	α-annealed, γ- quenched/ Nitric acid etched	C: 98, Fe: 85, Si: 60, Al: 38, N: 10, O < < 100	Weight gain	Open (Ar gas stream)	No	0.549	(Jackson et al. 1977)
150	80	26.7	5.6	Unirradiated U	n/a	n/a	Oxide thickness (Interferometry)	n/a	n/a	0.152	(Grimes and Morris 1965)
151	80	26.7	5.6	Unirradiated U	n/a	n/a	Oxide thickness (Interferometry)	n/a	n/a	0.157	(Grimes and Morris 1965)
152	80	28.5	6.0	n/a	n/a	n/a	Volumetric, gravimetric, barometric studies and gas chromatography	Closed	Yes	0.69	(Kondo et al. 1964)
153	80	28.5	6.0	Unirradiated natural U rolled foil shaped into concave discs	α-annealed, γ- quenched/ Nitric acid etched	C: 98, Fe: 85, Si: 60, Al: 38, N: 10, O < < 100	Weight gain	Open (Ar gas stream)	No	0.692	(Jackson et al. 1977)
154	80	42.5	9.0	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.178	(Ritchie et al. 1986)
155	80	79.7	16.8	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.311	(Colmenares 1984)
156	80	79.7	16.8	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.295	(Colmenares 1984)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate ($mgU.\ cm^{-2}.\ h^{-1}$)	Reference
157	80	79.7	16.8	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.295	(Colmenares 1984)
158	80	79.7	16.8	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.332	(Colmenares 1984)
159	80	79.7	16.8	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.336	(Colmenares 1984)
160	80	79.7	16.8	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.341	(Colmenares 1984)
161	80	79.7	16.8	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.347	(Colmenares 1984)
162	80	79.7	16.8	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.349	(Colmenares 1984)
163	80	79.7	16.8	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.351	(Colmenares 1984)
164	80	80.8	17.1	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.28	(Ritchie et al. 1986)
165	80	123.4	26.1	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.381	(Ritchie et al. 1986)
166	80	199.00	42.1	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.421	(Ritchie et al. 1986)
167	80	199.0	42.1	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.439	(Ritchie et al. 1986)
168	80	200.0	42.3	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.536	(Ritchie et al. 1986)
169	80	353.6	74.8	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.52	(Ritchie et al. 1986)
170	80	472.7	100	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	No	1.742	(Orman 1963)
171	80	472.7	100	Unirradiated U rod	Mg-reduced/ Nitric acid etched	Fe, Si, Al, C	H_2 generation/ Weight gain	Closed	n/a	0.95	(Baker and Less et al. 1966, Ritchie 1981)
172	80	472.7	100	Unirradiated U rod	Mg-reduced/n Nitric acid etched	Fe, Si, Al, C	H_2 generation/ Weight gain	Closed	n/a	1.49	(Baker and Less et al. 1966)
173	80.2	203.5	42.7	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.382	(Ritchie et al. 1986)
174	80.2	317.9	66.7	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.763	(Ritchie et al. 1986)
175	80.3	43.5	9.1	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.241	(Ritchie et al. 1986)
176	80.4	12.5	2.6	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.124	(Ritchie et al. 1986)
177	80.4	13.9	2.9	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.157	(Ritchie et al. 1986)
178	80.4	25.0	5.2	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.165	(Ritchie et al. 1986)
179	80.5	24.1	5.0	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.196	(Ritchie et al. 1986)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
180	80.5	42.5	8.8	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.243	(Ritchie et al. 1986)
181	80.5	73.8	15.3	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.278	(Ritchie et al. 1986)
182	80.5	125.9	26.1	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.361	(Ritchie et al. 1986)
183	80.5	198.7	41.2	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.548	(Ritchie et al. 1986)
184	80.5	314.5	65.2	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.721	(Ritchie et al. 1986)
185	80.6	74.1	15.3	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.293	(Ritchie et al. 1986)
186	81.2	127.5	25.7	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.375	(Ritchie et al. 1986)
187	81.4	204.6	40.9	Depleted U square coupon	Nitric acid etched	High purity	Weight gain or loss	Open (N_2 carrier gas)	n/a	0.487	(Ritchie et al. 1986)
188	98	3.8	0.4	Unirradiated natural U rolled foil shaped into concave discs	α-annealed,γ-quenched/ Nitric acid etched	C: 98, Fe: 85, Si: 60, Al: 38, N: 10, O < < 100	Weight gain	Open/ Ar gas stream	No	0.362	(Jackson et al. 1977)
189	98	4.0	0.4	n/a	n/a	n/a	Volumetric, gravimetric, barometric studies and gas chromatography	Closed	Intermediate***	0.360	(Kondo et al. 1964)
190	98	58.0	6.2	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream)	No	0.088*	(Abrefah and Sell 1999)
191	99	56.0	5.7	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream)	No	0.462*	(Abrefah and Sell 1999)
192	100	0.065	0.006	Depleted - U	α-annealed/ Mechanically polished	n/a	Weight gain	Static/ Closed	n/a	0.041	(Colmenares 1984)
193	100	0.12	0.012	Depleted - U	α-annealed/ Mechanically polished	n/a	Weight gain	Static/ Closed	n/a	0.052	(Colmenares 1984)
194	100	0.15	0.015	Depleted - U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.056	(Colmenares 1984)
195	100	2.7	0.266	Depleted U (D38) coupon	Mechanical polishing SIC (600 grit size)	C: 19, O: 18, N: 17, Fe: 12, Mg: 11, Al: 10, Si: 10, Mn: 8, Ni: 5, Cr: 3, Cu: 2, P: 1	Weight gain	Closed system (Decreasing P-H_2O -Opened periodically)	Yes	0.274	(Weirick 1984)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate ($mgU.\,cm^{-2}.\,h^{-1}$)	Reference
196	100	2.7	0.266	Depleted U (D38) coupon	Mechanical polishing SIC (600 grit size)	C: 19, O: 18, N: 17, Fe: 12, Mg: 11, Al: 10, Si: 10, Mn: 8, Ni: 5, Cr: 3, Cu: 2, P: 1	Weight gain	Open system	n/a	0.16	(Weirick 1984)
197	100	2.7	0.266	Depleted U (D38) coupon	Mechanical polishing SIC (600 grit size)	C: 19, O: 18, N: 17, Fe: 12, Mg: 11, Al: 10, Si: 10, Mn: 8, Ni: 5, Cr: 3, Cu: 2, P: 1	Weight gain	Open system	n/a	0.17	(Weirick 1984)
198	100	3	0.3	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Static/ Closed	n/a	0.216	(Colmenares 1984)
199	100	6.1	0.6	n/a	n/a	n/a	Weight gain	Closed	n/a	0.743	(Santon 1964)
200	100	6.7	0.7	Depleted U (D38) coupon	Mechanical polishing SIC (600 grit size)	C: 19, O: 18, N: 17, Fe: 12, Mg: 11, Al: 10, Si: 10, Mn: 8, Ni: 5, Cr: 3, Cu: 2, P: 1	Weight gain	Closed system (Decreasing P-H_2O -Opened periodically)	Yes	0.351	(Weirick 1984)
201	100	9.5	0.9	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	0.17	(Orman 1964)
202	100	13	1.3	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	0.43	(Orman 1964)
203	100	13.3	1.3	Depleted U (D38) coupon	Mechanical polishing SIC (600 grit size)	C: 19, O: 18, N: 17, Fe: 12, Mg: 11, Al: 10, Si: 10, Mn: 8, Ni: 5, Cr: 3, Cu: 2, P: 1	Weight gain	Closed system (Decreasing P-H_2O -Opened periodically)	Yes	0.35	(Weirick 1984)
204	100	13.3	1.3	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Static/ Closed	n/a	0.372	(Colmenares 1984)
205	100	15.9	1.6	Unirradiated natural U rolled foil shaped into concave discs	α-annealed, γ- quenched/ Nitric acid etched	C: 98, Fe: 85, Si: 60, Al: 38, N: 10, O < < 100	Weight gain	Open (Ar gas stream)	No	1.3	(Jackson et al. 1977)
206	100	20	2.0	Depleted U (D38) coupon	Mechanical polishing SIC (600 grit size)	C: 19, O: 18, N: 17, Fe: 12, Mg: 11, Al: 10, Si: 10, Mn: 8, Ni: 5, Cr: 3, Cu: 2, P: 1	Weight gain	Closed system (Decreasing P-H_2O -Opened periodically)	Yes	0.374	(Weirick 1984)
207	100	20	2.0	Depleted U (D38) coupon	Mechanical polishing SIC (600 grit size)	C: 19, O: 18, N: 17, Fe: 12, Mg: 11, Al: 10, Si: 10, Mn: 8, Ni: 5, Cr: 3, Cu: 2, P: 1	Weight gain	Open system	n/a	0.45	(Weirick 1984)
208	100	22.2	2.2	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	0.49	(Orman 1964)
209	100	27.8	2.7	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	0.48	(Orman 1964)
210	100	28.5	2.8	Unirradiated natural U rolled foil shaped into concave discs	α-annealed, γ- quenched/ Nitric acid etched	C: 98, Fe: 85, Si: 60, Al: 38, N: 10, O < < 100	Weight gain	Open (Ar gas stream)	No	1.57	(Jackson et al. 1977)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
211	100	30	3.0	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Static/ Closed	n/a	0.595	(Colmenares 1984)
212	100	31.7	3.1	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	0.73	(Orman 1964)
213	100	50	4.9	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.818	(Colmenares 1984)
214	100	57	5.6	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream	n/a	0.537*	(Abrefah and Sell 1999)
215	100	79.7	7.9	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.893	(Colmenares 1984)
216	100	79.7	7.9	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	1.125	(Colmenares 1984)
217	100	79.7	7.9	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.870	(Colmenares 1984)
218	100	79.7	7.9	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	0.901	(Colmenares 1984)
219	100	79.7	7.9	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	1.02	(Colmenares 1984)
220	100	79.7	7.9	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	1.01	(Colmenares 1984)
221	100	79.7	7.9	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	1.01	(Colmenares 1984)
222	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Static/ Closed	n/a	1.46	(Colmenares 1984)
223	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	1.64	(Colmenares 1984)
224	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	1.74	(Colmenares 1984)
225	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	n/a	Weight gain	Open (N_2 carrier gas)	n/a	1.79	(Colmenares 1984)
226	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	Low purity - Total 457 (C: 31, Al: 5, Si: 15, Mn: 45, Fe: 142, W < 100, P < 100, Cu:11)	Weight gain	Open (N_2 carrier gas)	n/a	2.37	(Colmenares 1984)
227	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	Low purity - Total 457 (C: 31, Al: 5, Si: 15, Mn: 45, Fe: 142, W < 100, P < 100, Cu:11)	Weight gain	Open (N_2 carrier gas)	n/a	2.01	(Colmenares 1984)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate ($mgU.\ cm^{-2}.\ h^{-1}$)	Reference
228	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	Low purity - Total 457 (C: 31, Al: 5, Si: 15, Mn: 45, Fe: 142, W < 100, P < 100, Cu:11)	Weight gain	Open (N_2 carrier gas)	n/a	1.95	(Colmenares 1984)
229	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	Low purity - Total 457 (C: 31, Al: 5, Si: 15, Mn: 45, Fe: 142, W < 100, P < 100, Cu:11)	Weight gain	Open (N_2 carrier gas)	n/a	1.87	(Colmenares 1984)
230	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	Low purity - Total 457 (C: 31, Al: 5, Si: 15, Mn: 45, Fe: 142, W < 100, P < 100, Cu:11)	Weight gain	Open (N_2 carrier gas)	n/a	1.85	(Colmenares 1984)
231	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	Low purity - Total 457 (C: 31, Al: 5, Si: 15, Mn: 45, Fe: 142, W < 100, P < 100, Cu:11)	Weight gain	Open (N_2 carrier gas)	n/a	1.91	(Colmenares 1984)
232	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	Low purity - Total 457 (C: 31, Al: 5, Si: 15, Mn: 45, Fe: 142, W < 100, P < 100, Cu:11)	Weight gain	Open (N_2 carrier gas)	n/a	1.81	(Colmenares 1984)
233	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	High purity - Total 97 (C: 19, N: 17, O: 18, Al: 10, Ni: 5, Si: 10, Mg: 11, Mn: 7.7, Fe: 12)	Weight gain	Open (N_2 carrier gas)	n/a	1.15	(Colmenares 1984)
234	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	High purity - Total 97 (C: 19, N: 17, O: 18, Al: 10, Ni: 5, Si: 10, Mg: 11, Mn: 7.7, Fe: 12)	Weight gain	Open (N_2 carrier gas)	n/a	1.25	(Colmenares 1984)
235	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	High purity - Total 97 (C: 19, N: 17, O: 18, Al: 10, Ni: 5, Si: 10, Mg: 11, Mn: 7.7, Fe: 12)	Weight gain	Open (N_2 carrier gas)	n/a	1.42	(Colmenares 1984)
236	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	High purity - Total 97 (C: 19, N: 17, O: 18, Al: 10, Ni: 5, Si: 10, Mg: 11, Mn: 7.7, Fe: 12)	Weight gain	Open (N_2 carrier gas)	n/a	1.55	(Colmenares 1984)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
237	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	High purity - Total 97 (C: 19, N: 17, O: 18, Al: 10, Ni: 5, Si: 10, Mg: 11, Mn: 7.7, Fe: 12)	Weight gain	Open (N_2 carrier gas)	n/a	1.55	(Colmenares 1984)
238	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	High purity - Total 97 (C: 19, N: 17, O: 18, Al: 10, Ni: 5, Si: 10, Mg: 11, Mn: 7.7, Fe: 12)	Weight gain	Open (N_2 carrier gas)	n/a	1.50	(Colmenares 1984)
239	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	High purity - Total 97 (C: 19, N: 17, O: 18, Al: 10, Ni: 5, Si: 10, Mg: 11, Mn: 7.7, Fe: 12)	Weight gain	Open (N_2 carrier gas)	n/a	1.46	(Colmenares 1984)
240	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	High purity - Total 97 (C: 19, N: 17, O: 18, Al: 10, Ni: 5, Si: 10, Mg: 11, Mn: 7.7, Fe: 12)	Weight gain	Open (N_2 carrier gas)	n/a	1.50	(Colmenares 1984)
241	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	High purity - Total 97 (C: 19, N: 17, O: 18, Al: 10, Ni: 5, Si: 10, Mg: 11, Mn: 7.7, Fe: 12)	Weight gain	Open (N_2 carrier gas)	n/a	1.51	(Colmenares 1984)
242	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	High purity - Total 97 (C: 19, N: 17, O: 18, Al: 10, Ni: 5, Si: 10, Mg: 11, Mn: 7.7, Fe: 12)	Weight gain	Open (N_2 carrier gas)	n/a	1.54	(Colmenares 1984)
243	100	133.3	13.1	Depleted-U	α-annealed/ Mechanically polished	High purity - Total 97 (C: 19, N: 17, O: 18, Al: 10, Ni: 5, Si: 10, Mg: 11, Mn: 7.7, Fe: 12)	Weight gain	Open (N_2 carrier gas)	n/a	1.52	(Colmenares 1984)
244	100	232	22.9	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	1.74	(Orman 1964)
245	100	420	41.5	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	2.0	(Orman 1964)
246	100	510	50.3	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	1.57	(Orman 1964)
247	100	569	56.2	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	2.29	(Orman 1964)
248	100	661	65.2	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	2.62	(Orman 1964)
249	100	701	69.2	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	3.48	(Orman 1964)
250	100	739	72.9	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	3.18	(Orman 1964)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
251	100	808	79.7	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	3.44	(Orman 1964)
252	100	873	86.2	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	3.76	(Orman 1964)
253	100	926.5	91.4	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	3.21	(Orman 1964)
254	100	978.6	96.6	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	3.95	(Orman 1964)
255	100	997	98.4	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	4.3	(Orman 1964)
256	100	1000	98.7	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	4.34	(Orman 1964)
257	100	1007	99.4	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	4.18	(Orman 1964)
258	100	1013.3	100.0	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	n/a	4.75	(Orman 1964)
259	100	1013.3	100.0	Unirradiated U rod	Mg-reduced/ Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	No	4.75	(Orman 1963)
260	100	1013.3	100.0	Unirradiated U rod	Mg-reduced/ Nitric acid etched	Fe, Si, Al, C	H_2 generation/ Weight gain	Closed	Yes	3.30	(Baker and Less et al. 1966)
261	105	73	7.2	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream	No	0.181*	(Abrefah and Sell 1999)
262	105	208	20.5	Natural-U	n/a	n/a	n/a	n/a	n/a	0.112	(Pearce and Kay 1987)
263	105	790	78.0	Natural-U	n/a	n/a	n/a	n/a	n/a	1.77	(Pearce and Kay 1987)
264	105	1000	98.7	Natural-U	n/a	n/a	n/a	n/a	n/a	2.98	(Pearce and Kay 1987)
265	108	82	8.1	Unirradiated uranium alloy 601	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream	No	0.118*	(Abrefah and Sell 1999)
266	129	68	6.7	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream	No	0.869*	(Abrefah and Sell 1999)
267	132	79	7.8	Unirradiated uranium alloy 601	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream	No	0.196*	(Abrefah and Sell 1999)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
268	133	61	6.0	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream	No	0.552*	(Abrefah and Sell 1999)
269	134	72	7.1	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream	No	0.367*	(Abrefah and Sell 1999)
270	150	3.8	0.4	Unirradiated natural U rolled foil shaped into concave discs	α-annealed, γ- quenched/ Nitric acid etched	C: 98, Fe: 85, Si: 60, Al: 38, N: 10, O < < 100	Weight gain	Open (Ar gas stream)	No	0.581	(Jackson et al. 1977)
271	150	15.9	1.6	Unirradiated natural U rolled foil shaped into concave discs	α-annealed, γ- quenched/ Nitric acid etched	C: 98, Fe: 85, Si: 60, Al: 38, N: 10, O < < 100	Weight gain	Open (Ar gas stream)	No	2.41	(Jackson et al. 1977)
272	150	28.5	2.8	Unirradiated natural U rolled foil shaped into concave discs	α-annealed, γ- quenched/ Nitric acid etched	C: 98, Fe: 85, Si: 60, Al: 38, N: 10, O < < 100	Weight gain	Open (Ar gas stream)	No	3.01	(Jackson et al. 1977)
273	150	51	5.0	Natural-U	n/a	n/a	n/a	n/a	n/a	2.08	(Pearce and Kay 1987)
274	150	210	20.7	Natural-U	n/a	n/a	n/a	n/a	n/a	3.27	(Pearce and Kay 1987)
275	150	210	20.7	Natural-U	n/a	n/a	n/a	n/a	n/a	3.79	(Pearce and Kay 1987)
276	150	490	48.4	Natural-U	n/a	n/a	n/a	n/a	n/a	5.36	(Pearce and Kay 1987)
277	150	490	48.4	Natural-U	n/a	n/a	n/a	n/a	n/a	5.58	(Pearce and Kay 1987)
278	150	490	48.4	Natural-U	n/a	n/a	n/a	n/a	n/a	5.73	(Pearce and Kay 1987)
279	150	790	78.0	Natural-U	n/a	n/a	n/a	n/a	n/a	9.37	(Pearce and Kay 1987)
280	150	1013.3	100	Natural-U	n/a	n/a	n/a	Open	n/a	16.07	(Wathen 1943)
281	160	58	5.7	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream	No	3.174*	(Abrefah and Sell 1999)
282	160	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open system (Ar gas stream)	Yes	8.93	(Hopkinson 1959)
283	161	57	5.6	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream)	No	4.570*	(Abrefah and Sell 1999)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
284	161	76	7.5	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream)	No	3.901*	(Abrefah and Sell 1999)
285	162	74	7.3	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream)	No	1.950*	(Abrefah and Sell 1999)
286	162	74	7.3	Unirradiated uranium alloy 601	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream)	No	1.980*	(Abrefah and Sell 1999)
287	162	76	7.5	Unirradiated uranium alloy 601	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream)	No	1.731*	(Abrefah and Sell 1999)
288	163	72	7.1	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream)	No	1.353*	(Abrefah and Sell 1999)
289	169	77	7.6	Unirradiated uranium alloy 601	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream)	No	3.590*	(Abrefah and Sell 1999)
290	180	490	48.4	Natural-U	n/a	n/a	n/a	n/a	n/a	13.5	(Pearce and Kay 1987)
291	180	490	48.4	Natural-U	n/a	n/a	n/a	n/a	n/a	13.9	(Pearce and Kay 1987)
292	180	790	78.0	Natural-U	n/a	n/a	n/a	n/a	n/a	14.1	(Pearce and Kay 1987)
293	199	1013.3	100	Natural U foil	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	25.5	(Hayward et al. 1994)
294	199	1013.3	100	Extruded Natural U pellet	Extruded/ Mechanical polishing (600 grit C) and nitric acid etched	Fe < 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	36.2	(Hayward et al. 1994)
295	200	210	20.7	Natural-U	n/a	n/a	n/a	n/a	n/a	15.8	(Pearce and Kay 1987)
296	200	490	48.4	Natural-U	n/a	n/a	n/a	n/a	n/a	22.3	(Pearce and Kay 1987)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
297	200	790	78.0	Natural-U	n/a	n/a	n/a	n/a	n/a	37.6	(Pearce and Kay 1987)
298	200	1000	98.7	Natural-U	n/a	n/a	n/a	n/a	n/a	43.5	(Pearce and Kay 1987)
299	200	1013.3	100	Extruded Natural U pellet	Extruded/ Mechanical polishing (600 grit C) and nitric acid etched	Fe < 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	36.9	(Hayward et al. 1994)
300	200	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	35.7	(Hopkinson 1959)
301	200	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	44.63	(Hopkinson 1959)
302	200	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	44.63	(Hopkinson 1959)
303	200	1013.3	100	Natural -U	n/a	n/a	n/a	n/a	n/a	104.1	(Huddle 1953)
304	200	1013.3	100	Natural-U	n/a	n/a	n/a	Open	n/a	119	(Wathen 1943)
305	201	1013.3	100	Natural U foil	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	22.8	(Hayward et al. 1994)
306	201	1013.3	100	Natural U foil	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	24.0	(Hayward et al. 1994)
307	201	1013.3	100	Natural U foil	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	22.3	(Hayward et al. 1994)
308	204	1013.3	100	n/a	n/a	n/a	Weight gain	Closed	n/a	17.3	(Santon 1964)
309	211	67	6.6	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream	No	6.27*	(Abrefah and Sell 1999)
310	211	72	7.1	Uranium alloy 601 -(Irradiated)	Extruded/ Mechanical polishing (600-grit)	Al: 700–900, C: 365–735, Cr: 65, Cu: 75, Fe: 300–400, Ni: 100, N: 75, Si: 124, Zr: 65, Mn: 25, Mg: 25	Weight gain	Open (He-H2O gas stream	No	6.73*	(Abrefah and Sell 1999)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
311	225	13789.5	Superheated steam	Defected and open end unirradiated ingot U fuel element	Nitric acid etched	C: 300	Weight loss and H_2 gas generation	Closed	Yes	3652**	(Troutner 1960)
312	230	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	133.9	(Hopkinson 1959)
313	230	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	133.9	(Hopkinson 1959)
314	230	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	713.8	(Hopkinson 1959)
315	240	490	48.4	Natural-U	n/a	n/a	n/a	n/a	n/a	127.2	(Pearce and Kay 1987)
316	250	490	48.4	Natural-U	n/a	n/a	n/a	n/a	n/a	126.5	(Pearce and Kay 1987)
317	250	490	48.4	Natural-U	n/a	n/a	n/a	n/a	n/a	145.1	(Pearce and Kay 1987)
318	250	790	78.0	Natural-U	n/a	n/a	n/a	n/a	n/a	250.7	(Pearce and Kay 1987)
319	250	1013.3	100	Extruded Natural U pellet	Extruded/ Mechanical polishing (600 grit C) and nitric acid etched	Fe < 7	Weight gain	Open (Ar gas stream)	Heavily oxidised (not detected)	150.7	(Hayward et al. 1994)
320	250	1013.3	100	Extruded Natural U pellet	Extruded/ Mechanical polishing (600 grit C) and nitric acid etched	Fe < 7	Weight gain	Open (Ar gas stream)	Heavily oxidised (not detected)	176.9	(Hayward et al. 1994)
321	250	1013.3	100	As-cast natural U rectangular sheet	Hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	401.6	(Hopkinson 1959)
322	250	1013.3	100	As-cast natural U rectangular sheet	Hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	714	(Hopkinson 1959)
323	250	1013.3	100	As-cast natural U rectangular sheet	Hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	714	(Hopkinson 1959)
324	250	1013.3	100	Natural -U	n/a	n/a	n/a	n/a	n/a	593.5	(Huddle 1953)
325	250	1013.3	100	Natural-U	n/a	n/a	n/a	Open	n/a	1197	(Wathen 1943)
326	252	1013.3	100	Natural U foil	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	74.9	(Hayward et al. 1994)
327	252	1013.3	100	Natural U foil	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	79.6	(Hayward et al. 1994)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
328	270	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	758.6	(Hopkinson 1959)
329	270	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	847.9	(Hopkinson 1959)
330	270	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	847.9	(Hopkinson 1959)
331	285	1013.3	100	Extruded Natural U pellet	Extruded/ Mechanical polishing (600 grit C) and nitric acid etched	Fe < 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	284.1	(Hayward et al. 1994)
332	285	1013.3	100	Extruded Natural U pellet	Extruded/ Mechanical polishing (600 grit C) and nitric acid etched	Fe < 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	312.1	(Hayward et al. 1994)
333	300	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	892.5	(Hopkinson 1959)
334	300	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	1071	(Hopkinson 1959)
335	300	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	1204.9	(Hopkinson 1959)
336	300	1013.3	100	Natural -U	n/a	n/a	n/a	n/a	n/a	521.9	(Huddle 1953)
337	300	1013.3	100	Natural-U	n/a	n/a	n/a	Open	n/a	1435	(Wathen 1943)
338	300	13789.5	Superheated steam	Defected and open end unirradiated ingot U fuel element	α -hot-rolled, extruded/ Nitric acid etched	C: 300	Weight loss and H_2 gas generation	Closed	Yes	10413**	(Troutner 1960)
339	300	68947.6	Superheated steam	Defected and open end unirradiated ingot U fuel element	α -hot-rolled, extruded/ Nitric acid etched	C: 300	Weight loss and H_2 gas generation	Closed	Yes	18928**	(Troutner 1960)
340	301	1013.3	100	Natural U foil	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	239.2	(Hayward et al. 1994)
341	301	1013.3	100	Extruded Natural U pellet	Extruded/ Mechanical polishing (600 grit C) and nitric acid etched	Fe < 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	479.8	(Hayward et al. 1994)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate ($mgU.\,cm^{-2}.\,h^{-1}$)	Reference
342	301	1013.3	100	Extruded Natural U pellet	Extruded/ Mechanical polishing (600 grit C) and nitric acid etched	Fe < 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	526.0	(Hayward et al. 1994)
343	302	1013.3	100	Natural U foil	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	225.7	(Hayward et al. 1994)
344	325	490	48.4	Natural-U	n/a	n/a	n/a	n/a	n/a	389.9	(Pearce and Kay 1987)
345	325	1013.3	100	Extruded Natural U pellet	Extruded/ Mechanical polishing (600 grit C) and nitric acid etched	Fe < 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	480.3	(Hayward et al. 1994)
346	327	1013.3	100	Extruded Natural U pellet	Extruded/ Mechanical polishing (600 grit C) and nitric acid etched	Fe < 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	445.6	(Hayward et al. 1994)
347	330	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open system (Ar-steam gas stream)	Yes	937.1	(Hopkinson 1959)
348	349	1013.3	100	Extruded Natural U pellet	Extruded/ Mechanical polishing (600 grit C) and nitric acid etched	Fe < 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	619.2	(Hayward et al. 1994)
349	350	1013.3	100	Extruded Natural U pellet	Extruded/ Mechanical polishing (600 grit C) and nitric acid etched	Fe < 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	586.6	(Hayward et al. 1994)
350	350	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	714	(Hopkinson 1959)
351	350	1013.3	100	Natural -U	n/a	n/a	n/a	n/a	n/a	889.5	(Huddle 1953)
352	351	1013.3	100	Extruded Natural U pellet	Extruded/ Mechanical polishing (600 grit C) and nitric acid etched	Fe < 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	468.4	(Hayward et al. 1994)
353	352	1013.3	100	Extruded Natural U pellet	Extruded/ Mechanical polishing (600 grit C) and nitric acid etched	Fe < 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	445.6	(Hayward et al. 1994)
354	352	1013.3	100	Natural U foil	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	374.8	(Hayward et al. 1994)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
355	353	1013.3	100	Natural U foil	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	412.6	(Hayward et al. 1994)
356	370	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	847.9	(Hopkinson 1959)
357	380	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	714	(Hopkinson 1959)
358	400	1013.3	100	Extruded Natural U pellet	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	405.6	(Hayward et al. 1994)
359	400	1013.3	100	Extruded Natural U pellet	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	322.6	(Hayward et al. 1994)
360	400	1013.3	100	Natural U foil	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	486.6	(Hayward et al. 1994)
361	400	1013.3	100	Natural -U	n/a	n/a	n/a	n/a	n/a	788.4	(Huddle 1953)
362	400	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	803.3	(Hopkinson 1959)
363	400	13789.5	Superheated steam	Defected and open end unirradiated ingot U fuel element	α -hot-rolled, extruded/ Nitric acid etched	C: 300	Weight loss and H_2 gas generation	Closed	Yes	20282**	(Troutner 1960)
364	400	68947.6	Superheated steam	Defected and open end unirradiated ingot U fuel element	α -hot-rolled, extruded/ Nitric acid etched	C: 300	Weight loss and H_2 gas generation	Closed	Yes	29750**	(Troutner 1960)
365	400	137895	Superheated steam	Defected and open end unirradiated ingot U fuel element	α -hot-rolled, extruded/ Nitric acid etched	C: 300	Weight loss and H_2 gas generation	Closed	Yes	44625**	(Troutner 1960)
366	420	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	535.5	(Hopkinson 1959)
367	420	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	624.8	(Hopkinson 1959)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
368	420	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	803.3	(Hopkinson 1959)
369	447	1013.3	100	Natural U foil	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	242.1	(Hayward et al. 1994)
370	450	1013.3	100	Extruded Natural U pellet	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)	191.0	(Hayward et al. 1994)
371	450	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	490.9	(Hopkinson 1959)
372	450	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	758.6	(Hopkinson 1959)
373	450	1013.3	100	Natural -U	n/a	n/a	n/a	n/a	n/a	506.5	(Huddle 1953)
374	451	1013.3	100	Extruded Natural U pellet	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Steam in Ar carrier gas)	Heavily oxidised (not detected)	69.0	(Hayward et al. 1994)
375	451	1013.3	100	Extruded Natural U pellet	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Steam in Ar carrier gas)	Heavily oxidised (not detected)	125.9	(Hayward et al. 1994)
376	499	1013.3	100	Natural U foil	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Steam in Ar carrier gas)	Heavily oxidised (not detected)	51.4	(Hayward et al. 1994)
377	500	1013.3	100	Natural U foil	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Steam in Ar carrier gas)	Heavily oxidised (not detected)	62.6	(Hayward et al. 1994)
378	500	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	401.6	(Hopkinson 1959)
379	500	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	446.3	(Hopkinson 1959)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
380	500	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Yes	580.1	(Hopkinson 1959)
381	500	1013.3	100	Natural -U	n/a	n/a	n/a	n/a	n/a	506.5	(Huddle 1953)
382	500	13789.5	Superheated steam	Defected and open end unirradiated ingot U fuel element	α hot-rolled, extruded/ Nitric acid etched	C: 300	Weight loss and H_2 gas generation	Closed	n/a	16229**	(Troutner 1960)
383	500	68947.6	Superheated steam	Defected and open end unirradiated ingot U fuel element	α hot-rolled, extruded/ Nitric acid etched	C: 300	Weight loss and H_2 gas generation	Closed	n/a	21636**	(Troutner 1960)
384	500	137895	Superheated steam	Defected and open end unirradiated ingot U fuel element	α hot-rolled, extruded/ Nitric acid etched	C: 300	Weight loss and H_2 gas generation	Closed	n/a	36511**	(Troutner 1960)
385	501	1013.3	100	Extruded Natural U pellet	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected) / Improbable (Dehydriding T)	202.0	(Hayward et al. 1994)
386	501	1013.3	100	Extruded Natural U pellet	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)/ Improbable (Dehydriding T)	182.4	(Hayward et al. 1994)
387	502	1013.3	100	Extruded Natural U pellet	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)/ Improbable (Dehydriding T)	274.1	(Hayward et al. 1994)
388	520	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable (Dehydriding T)	267.8	(Hopkinson 1959)
389	520	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable (Dehydriding T)	446.3	(Hopkinson 1959)
390	550	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	312.4	(Hopkinson 1959)
391	550	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	357	(Hopkinson 1959)
392	550	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	446.3	(Hopkinson 1959)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
393	550	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	490.3	(Hopkinson 1959)
394	552	1013.3	100	Extruded Natural U pellet	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)/ Improbable (Dehydriding T)	364.5	(Hayward et al. 1994)
395	600	1013.3	100	Extruded Natural U pellet	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)/ Improbable (Dehydriding T)	221.1	(Hayward et al. 1994)
396	600	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	575.3	(Hopkinson 1959)
397	600	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	663.8	(Hopkinson 1959)
398	600	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	752.3	(Hopkinson 1959)
399	600	1013.3	100	Natural -U	n/a	n/a	n/a	n/a	n/a	59.6	(Huddle 1953)
400	602	1013.3	100	Natural U foil	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)/ Improbable (Dehydriding T)	429.8	(Hayward et al. 1994)
401	603	1013.3	100	Extruded Natural U pellet	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Ar carrier gas)	Heavily oxidised (not detected)/ Improbable (Dehydriding T)	235.7	(Hayward et al. 1994)
402	620	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	418.0	(Scott 1959)
403	620	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	694.7	(Scott 1959)
404	620	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	758.6	(Scott 1959)
405	650	1013.3	100	Extruded Natural U pellet	Punched to shape/ Mechanical polishing (600 grit C) and nitric acid etched	Fe: 110, Zr: 14, Cu: 14, Cr: 14, Al: 70, Si: 35, Mg: 3, Ca: 7	Weight gain	Open (Steam in Ar carrier gas)	Heavily oxidised (not detected)/ Improbable (Dehydriding T)	221.1	(Hayward et al. 1994)
406	650	1013.3	100	As-cast natural U cylinder	As-cast/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open system (Ar-steam gas stream)	Improbable	619.5	(Hopkinson 1959)
407	650	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	663.8	(Hopkinson 1959)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
408	700	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	575.3	(Hopkinson 1959)
409	700	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	2655	(Hopkinson 1959)
410	730	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	2655	(Hopkinson 1959)
411	730	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	1026	(Scott 1959)
412	730	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	1562	(Scott 1959)
413	730	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	1569	(Scott 1959)
414	730	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	2581	(Scott 1959)
415	780	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	1755	(Scott 1959)
416	780	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	3384	(Scott 1959)
417	780	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	1770	(Hopkinson 1959)
418	800	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	215.7	(Lemmon 1957)
419	800	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	310.9	(Lemmon 1957)
420	800	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	429.9	(Lemmon 1957)
421	800	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	580.1	(Lemmon 1957)
422	800	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	733.3	(Lemmon 1957)
423	800	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	751.2	(Lemmon 1957)
424	820	1013.3	100	As-cast natural U cylinder	As-cast/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open system (Ar-steam gas stream)	Improbable due to dehydriding above 500C	1338.8	(Hopkinson 1959)
425	840	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	1338.8	(Hopkinson 1959)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
426	880	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	89.3	(Hopkinson 1959)
427	890	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	133.9	(Hopkinson 1959)
428	900	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	528.1	(Lemmon 1957)
429	900	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	728.9	(Lemmon 1957)
430	900	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	1019	(Lemmon 1957)
431	900	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	1592	(Lemmon 1957)
432	900	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	2135	(Lemmon 1957)
433	900	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	3057	(Lemmon 1957)
434	930	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	133.9	(Hopkinson 1959)
435	970	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	89.3	(Hopkinson 1959)
436	970	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	133.9	(Hopkinson 1959)
437	990	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	2016	(Scott 1959)
438	990	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	2573	(Scott 1959)
439	990	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	3458	(Scott 1959)
440	990	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	3778	(Scott 1959)
441	1000	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	89.3	(Hopkinson 1959)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
442	1000	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	133.9	(Hopkinson 1959)
443	1000	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	506	(Lemmon 1957)
444	1000	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	751	(Lemmon 1957)
445	1000	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	1086	(Lemmon 1957)
446	1000	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	1770	(Lemmon 1957)
447	1000	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	2581	(Lemmon 1957)
448	1020	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	89.3	(Hopkinson 1959)
449	1020	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	133.9	(Hopkinson 1959)
450	1060	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	133.9	(Hopkinson 1959)
451	1100	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	1458	(Scott 1959)
452	1100	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	2224	(Scott 1959)
453	1100	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	2425	(Scott 1959)
454	1100	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	2826	(Scott 1959)
455	1100	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	2923	(Scott 1959)
456	1100	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	2990	(Scott 1959)
457	1100	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	3533	(Scott 1959)
458	1100	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	5801	(Scott 1959)
459	1100	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	7943	(Scott 1959)
460	1125	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	2960	(Lemmon 1957)
461	1125	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	3630	(Lemmon 1957)

(*continued on next page*)

Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
462	1125	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	3823	(Lemmon 1957)
463	1200	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	1695.8	(Hopkinson 1959)
464	1215	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	3444	(Scott 1959)
465	1215	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	3570	(Scott 1959)
466	1215	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	4135	(Scott 1959)
467	1215	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	5801	(Scott 1959)
468	1215	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	6195	(Scott 1959)
469	1215	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	6909	(Scott 1959)
470	1215	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	8947	(Scott 1959)
471	1215	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	9029	(Scott 1959)
472	1215	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	9327	(Scott 1959)
473	1215	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	11394	(Scott 1959)
474	1215	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	11930	(Scott 1959)
475	1215	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	17404	(Scott 1959)
476	1215	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	17939	(Scott 1959)
477	1215	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	32398	(Scott 1959)
478	1230	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	2105	(Lemmon 1957)
479	1230	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	2871	(Lemmon 1957)
480	1230	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	3503	(Lemmon 1957)
481	1230	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	3979	(Lemmon 1957)
482	1230	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	3979	(Lemmon 1957)
483	1280	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	1830	(Lemmon 1957)
484	1280	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	2551	(Lemmon 1957)

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Table A1 (*continued*)

No.	T (ºC)	P (mbar)	Rh (%)	Material	Thermal treatment/ Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate (mgU. cm^{-2}. h^{-1})	Reference
485	1280	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	2930	(Lemmon 1957)
486	1280	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	4306	(Lemmon 1957)
487	1280	3447.4	Superheated steam	Natural-U rod	Forged in shape/ Mechanical polishing (60 and 180-grit paper)	C: 50, N: 50, O: 10, Si: 300, Mo: 40, Ni: 30, Fe: 100, Cr: 20, Al: 40, H: 2-10	H_2 generation	Open (Steam flow)	Improbable	4463	(Lemmon 1957)
488	1400	1013.3	100	As-cast natural U rectangular sheet	As-cast and hot-rolled/ Mechanical polishing (00 emery paper)	n/a	Weight gain	Open (Ar gas stream)	Improbable	2142	(Hopkinson 1959)
489	1440	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	6657	(Scott 1959)
490	1440	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	7326	(Scott 1959)
491	1440	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	8769	(Scott 1959)
492	1440	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	11156	(Scott 1959)
493	1440	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	16236	(Scott 1959)
494	1440	1013.3	100	Natural-U	n/a	n/a	n/a	n/a	n/a	16905	(Scott 1959)

*Considerable mass loss of corrosion product.

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Table A2
Uranium – Liquid Water Reaction.

No.	T (°C)	Reactant water	Material	Thermal treatment /Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate ($mgU.cm^{-2}.h^{-1}$)	Reference
1	20.6	K West basin water	Spent nuclear fuel	n/a	n/a	H_2 generation	Closed	n/a	0.001075	(Praga and Pajunen 1998)
2	20.6	K West basin water	Spent nuclear fuel	n/a	n/a	H_2 generation	Closed	n/a	0.000161	(Praga and Pajunen 1998)
3	21.7	K West basin water	Spent nuclear fuel	n/a	n/a	H_2 generation	Closed	n/a	0.000134	(Praga and Pajunen 1998)
4	21.7	K West basin water	Spent nuclear fuel	n/a	n/a	H_2 generation	Closed	n/a	0.00175	(Praga and Pajunen 1998)
5	25	Deionised water	Magnox natural U	As-cast/As received (thick layer)	C, N, O, Fe, Al	Oxide thickness	Rough static vacuum	n/a	0.01275	(Stitt et al. liquid 2018)
6	25	Deionised water	Magnox natural U	As-cast/As received (thick layer)	C, N, O, Fe, Al	Oxide thickness	Rough static vacuum	n/a	0.00792	(Stitt et al. liquid 2018)
7	25	Deionised water	Magnox natural U	As-cast/As received (thick layer)	C, N, O, Fe, Al	Oxide thickness	Rough static vacuum	n/a	0.00505	(Stitt et al. liquid 2018)
8	25	Deionised water	Magnox natural U	As-cast/Nitric acid etched	C, N, O, Fe, Al	Oxide thickness	Rough static vacuum	n/a	0.01534	(Stitt et al. liquid 2018)
9	25	Deionised water	Magnox natural U	As-cast/ Nitric acid etched	C, N, O, Fe, Al	Oxide thickness	Rough static vacuum	n/a	0.00136	(Stitt et al. liquid 2018)
10	25	Deionised water	Magnox natural U	As-cast/ Nitric acid etched	C, N, O, Fe, Al	Oxide thickness	Rough static vacuum	n/a	0.01534	(Stitt et al. liquid 2018)
11	25	Deionised water	Magnox natural U	As-cast/ Nitric acid etched	C, N, O, Fe, Al	Oxide thickness	Rough static vacuum	n/a	0.01874	(Stitt et al. liquid 2018)
12	25	Deionised water	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.0107	(Banos et al. part 1 2019)
13	25	Deionised water	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.0086	(Banos et al. part 1 2019)
14	25	Deionised water and 222.3 mbar D_2	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.0041	(Banos et al. part 2 2019)
15	25	Deionised water and 551.7 mbar D_2	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.003	(Banos et al. part 2 2019)
16	35	Degassed water	Unirradiated natural U rod	Mg-reduced/Nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	No	0.071	(Orman 1963)
17	35	Degassed water	Unirradiated natural U rod	Mg-reduced/Nitric acid etched	Fe, Si, Al, C	Weight gain/ H_2 generation	Closed	n/a	0.057	(Baker and Less et al. 1966)
18	37	Distilled water	As-cast tuballoy	n/a	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.0011	(Draley and English 1945)
19	37	Distilled water and dilute H_2O_2 (pH: 6.0-6.5)	As-cast tuballoy	n/a	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.002	(Draley and English 1945)
20	45	Deionised water	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.0262	(Banos et al. part 1 2019)
21	45	Deionised water	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.0098	(Banos et al. part 1 2019)

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Table A2 (*continued*)

No.	T (°C)	Reactant water	Material	Thermal treatment /Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate ($mgU.cm^{-2}.h^{-1}$)	Reference
22	45	Deionised water	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.0215	(Banos et al. part 1 2019)
23	45	Deionised water and 240 mbar D_2	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.0181	(Banos et al. part 2 2019)
24	45	Deionised water and 447.8 mbar D_2	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.0023	(Banos et al. part 2 2019)
25	45	Deionised water and 734.2 mbar D_2	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.0148	(Banos et al. part 2 2019)
26	50	Purified water	Natural uranium	Cold rolled/n/a	n/a	H_2 generation	n/a	n/a	0.0000098	(Waber 1958)
27	50	Purified water	Natural uranium	Cold rolled/n/a	n/a	Weight loss	n/a	n/a	0.000039	(Waber 1958)
28	50	Purified water	Natural uranium	Cold rolled/n/a	n/a	Weight loss	n/a	n/a	0.0000641	(Waber 1958)
29	50	Purified water	Natural uranium	Cold rolled/n/a	n/a	Weight loss	n/a	n/a	0.00012	(Waber 1958)
30	50	Purified water	Natural uranium	Cold rolled/n/a	n/a	Weight loss	n/a	n/a	0.00016	(Waber 1958)
31	50	Purified water	Natural uranium	Cold rolled/n/a	n/a	Weight loss	n/a	n/a	0.00026	(Waber 1958)
32	50	Purified water	Natural uranium	Cold rolled/n/a	n/a	Weight loss	n/a	n/a	0.00037	(Waber 1958)
33	50	Purified water	Natural uranium	Cold rolled/n/a	n/a	Weight loss	n/a	n/a	0.00043	(Waber 1958)
34	50	Purified water	Natural uranium	Cold rolled/n/a	n/a	H_2 generation	n/a	n/a	0.00058	(Waber 1958)
35	50	Distilled water	As-cast tuballoy	n/a	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.005	(Draley and English 1945)
36	50	Distilled water and dilute H_2O_2 (pH: 6.0-6.5)	As-cast tuballoy	n/a	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.005	(Draley and English 1945)
37	50	Aerated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Open in air	n/a	0.000498	(Mollison et al. 1945)
38	50	Aerated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Open in air	n/a	0.00124	(Mollison et al. 1945)
39	50	Aerated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Open in air	n/a	0.00246	(Mollison et al. 1945)
40	50	H_2-saturated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.062	(Mollison et al. 1945)
41	50	O_2-saturated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.036	(Mollison et al. 1945)
42	50	Degassed water	Unirradiated natural U rod	Mg-reduced/nitric-acid etched	Fe, Si, Al, C	Weight gain/ H_2 generation	Closed	n/a	0.19	(Baker and Less et al. 1966)
43	55	Deionised water	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.0148	(Banos et al. part 1 2019)
44	55	Deionised water	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.0799	(Banos et al. part 1 2019)
45	55	Deionised water	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.0612	(Banos et al. part 1 2019)
46	55	Deionised water and 151 mbar D_2	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.044	(Banos et al. part 2 2019)
47	55	Deionised water and 416 mbar D_2	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.044	(Banos et al. part 2 2019)
48	55	Deionised water and 728 mbar D_2	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.017	(Banos et al. part 2 2019)
49	55	Deionised deuterated water and 280 mbar H_2	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	Gas generation	Closed	Yes	0.0093	(Banos et al. report 2018)
50	55	Deionised water and 294.7 mbar Ar	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	Gas generation	Closed	Yes	0.021	(Banos et al. part 3 2020)

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Table A2 (*continued*)

No.	T (°C)	Reactant water	Material	Thermal treatment /Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate ($mgU.cm^{-2}.h^{-1}$)	Reference
51	60	Distilled water	As-cast tuballoy	n/a	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.011	(Draley and English 1945)
52	60	Distilled water and dilute H_2O_2 (pH: 6.0-6.5)	As-cast tuballoy	n/a	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.007	(Draley and English 1945)
53	60	Aerated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Open in air	n/a	0.017	(Mollison et al. 1945)
54	60	Aerated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Open in air	n/a	0.0219	(Mollison, English et al. 1945)
55	60	Aerated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Open in air	n/a	0.03	(Mollison, English et al. 1945)
56	60	Aerated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Open in air	n/a	0.0838	(Mollison, English et al. 1945)
57	65	Degassed water	Unirradiated natural U rod	Mg-reduced/Nitric-acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	No	0.63	(Orman 1963)
58	65	Degassed water	Unirradiated natural U rod	Mg-reduced/ Nitric acid etched	Fe, Si, Al, C	Weight gain/ H_2 generation	Closed	n/a	0.665	(Baker and Less et al. 1966)
59	70	Distilled water	As-cast tuballoy	n/a	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.012	(Draley and English 1945)
60	70	Distilled water and dilute H_2O_2 (pH: 6.0-6.5)	As-cast tuballoy	n/a	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.015	(Draley and English 1945)
61	70	Distilled water	As-cast tuballoy	Finely polished	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.32	(Draley and English 1945)
62	70	Distilled water	As-cast tuballoy	Medium polished	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.46	(Draley and English 1945)
63	70	Distilled water	As-cast tuballoy	Coarse polished	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.40	(Draley and English 1945)
64	70	Deionised water	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.1166	(Banos et al. part 1 2019)
65	70	Deionised water	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.0996	(Banos et al. part 1 2019)
66	70	Deionised water and 447.9 mbar D_2	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	H_2 generation	Closed	Yes	0.016	(Banos et al. part 2 2019)
67	70	Deionised deuterated water and 181.9 mbar H_2	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	Gas generation	Closed	Yes	0.04	(Banos et al. report 2018)
68	70	Deionised deuterated water and 241.1 mbar Ar	Magnox natural U	As-cast/Mechanically polished (SiC -2500 grit size)	C, N, O, Fe, Al	Gas generation	Closed	Yes	0.023	(Banos et al. part 3 2020)
69	70	H_2-saturated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.35	(Mollison et al. 1945)
70	70	Aerated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Open in air	n/a	0.0097	(Mollison et al. 1945)
71	70	Aerated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Open in air	n/a	0.0096	(Mollison et al. 1945)
72	70	Aerated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Open in air	n/a	0.0212	(Mollison et al. 1945)
73	70	He-saturated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.21	(Mollison et al. 1945)
74	70	N_2-saturated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.25	(Mollison et al. 1945)
75	70	O_2-saturated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.003	(Mollison et al. 1945)

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Table A2 (*continued*)

No.	T (°C)	Reactant water	Material	Thermal treatment /Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate ($mgU.cm^{-2}.h^{-1}$)	Reference
76	80	Degassed water	Unirradiated natural U rod	As-cast/ Mechanically polished and nitric acid etched	C: 150, Fe: 98, Si: 17, Al: 15	Weight loss	Closed	No	1.75	(Orman 1963)
77	80	Distilled water	As-cast tuballoy	n/a	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.2	(Draley and English 1945)
78	80	Distilled water and dilute H_2O_2 (pH: 6.0-6.5)	As-cast tuballoy	n/a	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.03	(Draley and English 1945)
79	80	Aerated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Open in air	n/a	0.00938	(Mollison et al. 1945)
80	80	Aerated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Open in air	n/a	0.036	(Mollison et al. 1945)
81	80	Aerated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Open in air	n/a	0.1625	(Mollison et al. 1945)
82	80	Aerated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Open in air	n/a	0.661	(Mollison et al. 1945)
83	80	Aerated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Open in air	n/a	0.545	(Mollison et al. 1945)
84	80	Aerated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Open in air	n/a	0.685	(Mollison et al. 1945)
85	80	Degassed water	Unirradiated natural U rod	Mg-reduced/ Nitric acid etched	Fe, Si, Al, C	Weight gain/ H_2 generation	Closed	n/a	1.63	(Baker and Less et al. 1966)
86	90	Distilled water	As-cast tuballoy	n/a	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.7	(Draley and English 1945)
87	90	Distilled water and dilute H_2O_2 (pH: 6.0-6.5)	As-cast tuballoy	n/a	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.6	(Draley and English 1945)
88	90	H_2-saturated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	1.2	(Mollison et al. 1945)
89	90	O_2-saturated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	1.0	(Mollison et al. 1945)
90	90	Simulated J13 well water (pH: 8.65, 90.5 % O_2 sat.)	Depleted U from unirradiated EBR-11 blanket fuel	n/a	n/a	H_2 generation	Closed	Yes (Intermediate)	1.42	(Fonnesbeck 2000)
91	100	Distilled water	Natural U	n/a	n/a	Weight loss	n/a	n/a	0.78	(Greninger 1945)
92	100	Distilled water	Natural U	n/a	n/a	Weight loss	n/a	n/a	1.16	(Greninger 1945)
93	100	Distilled water	Natural U	n/a	n/a	Weight loss	n/a	n/a	0.77	(Greninger 1945)
94	100	Deionised water	Natural U cut from ingot	Hot α-rolled/ Mechanical polishing or nitric acid etching or electropolishing	n/a	Weight loss and H_2 generation	Closed	No (short oxidation)	2.93	(Schroeder et al. 1959)
95	100	Deionised water	Natural U cut from ingot	Hot α-rolled/ Mechanical polishing or nitric acid etching or electropolishing	n/a	Weight loss and H_2 generation	Closed	No (short oxidation)	3.04	(Schroeder et al. 1959)
96	100	Deionised water	Natural U cut from ingot	Hot α-rolled/ Mechanical polishing or nitric acid etching or electropolishing	n/a	Weight loss and H_2 generation	Closed	No (short oxidation)	3.28	(Schroeder et al. 1959)
97	100	Deionised water	Natural U cut from ingot	Hot α-rolled/ Mechanical polishing or nitric acid etching or electropolishing	n/a	Weight loss and H_2 generation	Closed	No (short oxidation)	2.7	(Schroeder et al. 1959)
98	100	Deionised water	Natural U cut from ingot	Hot α-rolled/ Mechanical polishing or nitric acid etching or electropolishing	n/a	Weight loss and H_2 generation	Closed	No (short oxidation)	3.5	(Schroeder et al. 1959)
99	100	H_2-saturated distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	2.7	(Mollison et al. 1945)
100	100	H_2-saturated distilled water	Natural U	As-cast	n/a	n/a	n/a	n/a	1.95	(McWhirter and Draley 1952)
101	100	H_2-saturated distilled water	Natural U	As-cast	n/a	n/a	n/a	n/a	2.51	(Feibig 1945)

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Table A2 (*continued*)

No.	T (°C)	Reactant water	Material	Thermal treatment /Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate ($mgU.cm^{-2}.h^{-1}$)	Reference
102	100	H_2-saturated distilled water	Natural U	As-cast	n/a	n/a	n/a	n/a	0.85-0.95	(Colbeck et al. 1945)
103	100	H_2-saturated distilled water	Natural U	As-cast	n/a	n/a	n/a	n/a	2.6-2.9	(Colbeck et al. 1945)
104	100	H_2-saturated distilled water (pH: 7.5-7.6)	Natural U	As-cast	Fe: 630, Si: 240, Cu: 660	n/a	n/a	n/a	2.0–2.2	(Colbeck et al. 1945)
105	100	H_2-saturated distilled water (pH: 9.0-9.2)	Natural U	As-cast	Fe: 630, Si: 240, Cu: 660	n/a	n/a	n/a	2.6-3.0	(Colbeck et al. 1945)
106	100	Distilled water (1 wt.% conc. NaCl)	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	1.73	(Mollison et al. 1945)
107	100	Distilled water (10 wt.% conc. NaCl)	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	1.41	(Mollison et al. 1945)
108	100	Distilled water (20 wt.% conc. NaCl)	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	1.43	(Mollison et al. 1945)
109	100	Distilled water (2 ppm cupric ion)	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	2.40	(Mollison et al. 1945)
110	100	Distilled water	As-cast tuballoy	As-cast/ Mechanically polished and nitric acid etched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	2.7	(Mollison et al. 1945)
111	100	Distilled water	As-cast tuballoy	As-cast/ 64 h at 100 °C, water quenched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	1.1	(Mollison et al. 1945)
112	100	Distilled water	As-cast tuballoy	As-cast/ 2 h at 900 °C, water quenched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.78	(Mollison et al. 1945)
113	100	Distilled water	As-cast tuballoy	As-cast/ 96 h at 900 °C, water quenched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	1.55	(Mollison et al. 1945)
114	100	Distilled water	As-cast tuballoy	As-cast/ 96 h at 900 °C, water quenched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	2.04	(Mollison et al. 1945)
115	100	Distilled water	As-cast tuballoy	As-cast/ 64 h at 850 °C, water quenched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	1.8	(Mollison et al. 1945)
116	100	Distilled water	As-cast tuballoy	As-cast/ 2 h at 725 °C, water quenched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	1.16	(Mollison et al. 1945)
117	100	Distilled water	As-cast tuballoy	As-cast/ 2 h at 600 °C, water quenched	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	2.17	(Mollison et al. 1945)
118	100	Distilled water	As-cast tuballoy	As-cast/ 2 h at 900 °C, furnace cooled	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	1.17	(Mollison et al. 1945)
119	100	Distilled water	As-cast tuballoy	As-cast/ 96 h at 900 °C, furnace cooled	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.94	(Mollison et al. 1945)
120	100	Distilled water	As-cast tuballoy	As-cast/ 96 h at 900 °C, furnace cooled	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	1.10	(Mollison et al. 1945)
121	100	Distilled water	As-cast tuballoy	As-cast/ 2 h at 725 °C, furnace cooled	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	1.68	(Mollison et al. 1945)
122	100	Distilled water	As-cast tuballoy	As-cast/ 2 h at 600 °C, furnace cooled	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	2.13	(Mollison et al. 1945)
123	100	Distilled water	As-cast tuballoy	As-cast/ 96 h at 900 °C water quenched and 600 °C furnace cooled	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.66	(Mollison et al. 1945)
124	100	Distilled water	As-cast tuballoy	As-cast/ 96 h at 900 °C water quenched and 600 °C furnace cooled	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	2.44	(Mollison et al. 1945)
125	100	Distilled water	As-cast tuballoy	Slow cooked and worked	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.77	(Mollison et al. 1945)
126	100	Distilled water	As-cast tuballoy	Slow cooked and unworked	C, Al, Cr, Fe, Si, Mo, Ti, Zn	Weight loss	Closed	n/a	0.77	(Mollison et al. 1945)

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Table A2 (*continued*)

No.	T (°C)	Reactant water	Material	Thermal treatment /Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate ($mgU.cm^{-2}.h^{-1}$)	Reference
127	100	Boiling distilled water	D547 natural U	As-cast, hot rolled, warm rolled and annealed/ Mechanical polishing (240 or 320 grit size) / α-annealed	C: 170, Al: 4, Ca: 10, Fe: 70, Mo: 25–250, Ni: 10, Si: 30	Weight loss	Closed	n/a	4.9	(Draley and McWhirter 1953)
128	100	Boiling distilled water	D547 natural U	As-cast, hot rolled, warm rolled and annealed/ Mechanical polishing (240 or 320 grit size) / β heat-treated	C: 170, Al: 4, Ca: 10, Fe: 70, Mo: 25–250, Ni: 10, Si: 30	Weight loss	Closed	n/a	3.8	(Draley and McWhirter 1953)
129	100	Boiling distilled water	D547 natural U	As-cast, hot rolled, warm rolled and annealed/ Mechanical polishing (240 or 320 grit size)/ γ heat-treated	C: 170, Al: 4, Ca: 10, Fe: 70, Mo: 25–250, Ni: 10, Si: 30	Weight loss	Closed	n/a	3.3	(Draley and McWhirter 1953)
130	100	Boiling distilled water	D547 natural U	As-cast, hot rolled, warm rolled and annealed/ Mechanical polishing (240 or 320 grit size) / 1 h 1000 °C water-quenched	C: 170, Al: 4, Ca: 10, Fe: 70, Mo: 25–250, Ni: 10, Si: 30	Weight loss	Closed	n/a	3.4	(Draley and McWhirter 1953)
131	100	Boiling distilled water	D547 natural U	As-cast, hot rolled, warm rolled and annealed/ Mechanical polishing (240 or 320 grit size) / 1 h 1000 °C furnace-cooled	C: 170, Al: 4, Ca: 10, Fe: 70, Mo: 25–250, Ni: 10, Si: 30	Weight loss	Closed	n/a	2.9	(Draley and McWhirter 1953)
132	100	Boiling distilled water	D547 natural U	As-cast, hot rolled, warm rolled and annealed/ Mechanical polishing (240 or 320 grit size) / 1 h 1000 °C water-quenched and 1 h 600 °C slow- cooled	C: 170, Al: 4, Ca: 10, Fe: 70, Mo: 25–250, Ni: 10, Si: 30	Weight loss	Closed	n/a	3.1	(Draley and McWhirter 1953)
133	100	Boiling distilled water	D547 natural U	As-cast, hot rolled, warm rolled and annealed/ Mechanical polishing (240 or 320 grit size) / 1 h 1000 °C furnace-cooled and 1 h 600 °C slow- cooled	C: 170, Al: 4, Ca: 10, Fe: 70, Mo: 25–250, Ni: 10, Si: 30	Weight loss	Closed	n/a	3.1	(Draley and McWhirter 1953)
134	100	Boiling distilled water	D550 natural U	As-cast, hot rolled and annealed/Mechanical polishing (240 or 320 grit size) / α-annealed	C: 250–270, Al: 2, Ca: 10, Fe: 100, Mg: 10, Ni: 15, Si: 25	Weight loss	Closed	n/a	4.9	(Draley and McWhirter 1953)
135	100	Boiling distilled water	D550 natural U	As-cast, hot rolled and annealed/Mechanical polishing (240 or 320 grit size)/ β heat-treated	C: 250–270, Al: 2, Ca: 10, Fe: 100, Mg: 10, Ni: 15, Si: 25	Weight loss	Closed	n/a	4.5	(Draley and McWhirter 1953)
136	100	Boiling distilled water	D550 natural U	As-cast, hot rolled and annealed/Mechanical polishing (240 or 320 grit size) / γ heat-treated	C: 250–270, Al: 2, Ca: 10, Fe: 100, Mg: 10, Ni: 15, Si: 25	Weight loss	Closed	n/a	3.2	(Draley and McWhirter 1953)
137	100	Boiling distilled water	D550 natural U	As-cast, hot rolled and annealed/Mechanical polishing (240 or 320 grit size) / 1 h 1000 °C water-quenched	C: 250–270, Al: 2, Ca: 10, Fe: 100, Mg: 10, Ni: 15, Si: 25	Weight loss	Closed	n/a	3.3	(Draley and McWhirter 1953)
138	100	Boiling distilled water	D550 natural U	As-cast, hot rolled and annealed/Mechanical polishing (240 or 320 grit size) / 1 h 1000 °C furnace-cooled	C: 250–270, Al: 2, Ca: 10, Fe: 100, Mg: 10, Ni: 15, Si: 25	Weight loss	Closed	n/a	2.6	(Draley and McWhirter 1953)

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Table A2 (*continued*)

No.	T (°C)	Reactant water	Material	Thermal treatment /Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate ($mgU.cm^{-2}.h^{-1}$)	Reference
139	100	Boiling distilled water	Mallinckrodt biscuit metal ingot 532	Hot rolled slow-cooled, 1 h 720 °C water quenched/Mechanical polishing (240 or 320 grit size)/α-annealed	C: 55, Al: 20, Ca < 20, Fe: 50, K < 20, Mg: 15, Mo < 20, Na: 10, Ni: 20, P < 20, Si: 20, Ti < 50, Zn < 20	Weight loss	Closed	n/a	4.3	(Draley and McWhirter 1953)
140	100	Boiling distilled water	Mallinckrodt biscuit metal ingot 532	Hot rolled slow-cooled, 1 h 720 °C water quenched/Mechanical polishing (240 or 320 grit size)/β heat-treated	C: 55, Al: 20, Ca < 20, Fe: 50, K < 20, Mg: 15, Mo < 20, Na: 10, Ni: 20, P < 20, Si: 20, Ti < 50, Zn < 20	Weight loss	Closed	n/a	3.1	(Draley and McWhirter 1953)
141	100	Boiling distilled water	Ingot B328 high purity natural U	Hot rolled, 600 °C slow-cooled, 1 h 700 °C water quenched and 1 h 800 °C water quenched /Mechanical polishing (240 or 320 grit size)/α-annealed	C: 44–55, Al: 5, As < 10, Ca < 20, Fe: 5, K < 20, P < 20, Si: 10, Ti < 50, Zn < 20	Weight loss	Closed	n/a	2.6	(Draley and McWhirter 1953)
142	100	Boiling distilled water	Ingot B328 high purity natural U	Hot rolled, 600 °C slow-cooled, 1 h 700 °C water quenched and 1 h 800 °C water quenched /Mechanical polishing (240 or 320 grit size)/β heat- treated	C: 44–55, Al: 5, As < 10, Ca < 20, Fe: 5, K < 20, P < 20, Si: 10, Ti < 50, Zn < 20	Weight loss	Closed	n/a	2.5	(Draley and McWhirter 1953)
143	100	Boiling distilled water	Ingot B328 high purity natural U	Hot rolled, 600 °C slow-cooled, 1 h 700 °C water quenched and 1 h 800 °C water quenched /Mechanical polishing (240 or 320 grit size)/γ heat- treated	C: 44–55, Al: 5, As < 10, Ca < 20, Fe: 5, K < 20, P < 20, Si: 10, Ti < 50, Zn < 20	Weight loss	Closed	n/a	2.5	(Draley and McWhirter 1953)
144	100	Boiling distilled water	Ingot B328 high purity natural U	Hot rolled, 600 °C slow-cooled, 1 h 700 °C water quenched and 1 h 800 °C water quenched /Mechanical polishing (240 or 320 grit size)/ 1 h 1000 °C water-quenched	C: 44–55, Al: 5, As < 10, Ca < 20, Fe: 5, K < 20, P < 20, Si: 10, Ti < 50, Zn < 20	Weight loss	Closed	n/a	2.6	(Draley and McWhirter 1953)
145	100	Boiling distilled water	Ingot B328 high purity natural U	Hot rolled, 600 °C slow-cooled, 1 h 700 °C water quenched and 1 h 800 °C water quenched /Mechanical polishing (240 or 320 grit size)/ 1 h 1000 °C furnace-cooled	C: 44–55, Al: 5, As < 10, Ca < 20, Fe: 5, K < 20, P < 20, Si: 10, Ti < 50, Zn < 20	Weight loss	Closed	n/a	2.6	(Draley and McWhirter 1953)
146	100	Degassed water	Unirradiated natural U rod	Mg-reduced/nitric-acid etched	Fe, Si, Al, C	Weight gain/ H_2 generation	Closed	n/a	3.65	(Baker and Less et al. 1966)
147	100	Degassed water	Unirradiated natural U rod	Mg-reduced/nitric-acid etched	Fe, Si, Al, C	Weight gain/ H_2 generation	Closed	n/a	4.0	(Baker and Less et al. 1966)
148	100	Degassed water	Unirradiated natural U rod	Mg-reduced/nitric-acid etched	Fe, Si, Al, C	Weight gain/ H_2 generation	Closed	n/a	4.2	(Baker and Less et al. 1966)
149	100	Degassed water	Unirradiated natural U rod	Mg-reduced/nitric-acid etched	Fe, Si, Al, C	Weight gain/ H_2 generation	Closed	n/a	4.25	(Baker and Less et al. 1966)
150	100	Degassed water	Unirradiated natural U rod	Mg-reduced/nitric-acid etched	Fe, Si, Al, C	Weight gain/ H_2 generation	Closed	n/a	4.15	(Baker and Less et al. 1966)

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Table A2 (*continued*)

No.	T (°C)	Reactant water	Material	Thermal treatment /Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate ($mgU.cm^{-2}.h^{-1}$)	Reference
151	100	Degassed water	Unirradiated natural U rod	Mg-reduced/nitric-acid etched	Fe, Si, Al, C	Weight gain/ H_2 generation	Closed	n/a	4.35	(Baker and Less et al. 1966)
152	100	Degassed water	Unirradiated natural U rod	Mg-reduced/nitric-acid etched	Fe, Si, Al, C	Weight gain/ H_2 generation	Closed	n/a	4.2	(Baker and Less et al. 1966)
153	183	Distilled water and steam (10.34 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	139	(Bensen et al. 1945)
154	183	Distilled water and steam (10.34 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	117	(Bensen et al. 1945)
155	183	Distilled water and steam (10.34 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	122	(Bensen et al. 1945)
156	183	Distilled water and steam (10.34 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	106	(Bensen et al. 1945)
157	183	Distilled water and steam (10.34 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	156	(Bensen et al. 1945)
158	183	Distilled water and steam (10.34 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	137	(Bensen et al. 1945)
159	183	Distilled water and steam (10.34 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	160	(Bensen et al. 1945)
160	183	Distilled water and steam (10.34 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	157	(Bensen et al. 1945)
161	183	Distilled water and steam (10.34 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	145	(Bensen et al. 1945)
162	183	Distilled water and steam (10.34 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	163	(Bensen et al. 1945)
163	183	Distilled water and steam (10.34 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	114	(Bensen et al. 1945)

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Table A2 (*continued*)

No.	T (°C)	Reactant water	Material	Thermal treatment /Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate ($mgU.cm^{-2}.h^{-1}$)	Reference
164	183	Distilled water and steam (10.34 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	136	(Bensen et al. 1945)
165	183	Distilled water and steam (10.34 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	157	(Bensen et al. 1945)
166	183	Distilled water and 1 % Dichromate solution and steam (10.34 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	134	(Bensen et al. 1945)
167	183	Distilled water and 1 % Dichromate solution and steam (10.34 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	310	(Bensen et al. 1945)
168	183	Distilled water and 1 % Dichromate solution and steam (10.34 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	267	(Bensen et al. 1945)
169	200	Distilled water and steam (51.7 bar)	Natural U ingot or defected fuel element	α -hot-rolled/ Extruded	C: 300	Weight loss/ H_2 generation	Closed	Yes	38.5	(Troutner 1960)
170	200	Distilled water and steam (103.4 bar)	Natural U ingot or defected fuel element	α -hot-rolled/ Extruded	C: 300	Weight loss/ H_2 generation	Closed	Yes	42.8	(Troutner 1960)
171	200	Distilled water and steam (155.1 bar)	Natural U ingot or defected fuel element	α -hot-rolled/ Extruded	C: 300	Weight loss/ H_2 generation	Closed	Yes	35.4	(Troutner 1960)
172	225	Distilled water and steam (51.7 bar)	Natural U ingot or defected fuel element	α -hot-rolled/ Extruded	C: 300	Weight loss/ H_2 generation	Closed	Yes	101	(Troutner 1960)
173	225	Distilled water and steam (155.1 bar)	Natural U ingot or defected fuel element	α -hot-rolled/ Extruded	C: 300	Weight loss/ H_2 generation	Closed	Yes	117	(Troutner 1960)
174	226	Distilled water and steam (28.96 bar) and H_2 (1.03 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	721.66	(Bensen et al. 1945)
175	226	Distilled water and steam (28.96 bar) and H_2 (1.03 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	690	(Bensen et al. 1945)
176	226	Distilled water and steam (28.96 bar) and H_2 (1.03 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	690	(Bensen et al. 1945)
177	226	Distilled water and steam (28.96 bar) and H_2 (1.03 bar)	Natural U tuballoy	Hot rolled at 600 °C and cast/ Mechanically polished and nitric acid etched	Al: 100, C: 623, Cr: 20, Fe: 200, Si: 50, Mo < 100, Ti < 100, Zn < 50	Weight loss	Closed	Yes	785	(Bensen et al. 1945)
178	250	Distilled water and steam (51.7 bar)	Natural U ingot or defected fuel element	α -hot-rolled/ Extruded	C: 300	Weight loss/ H_2 generation	Closed	Yes	222	(Troutner 1960)
179	250	Distilled water and steam (103.4 bar)	Natural U ingot or defected fuel element	α -hot-rolled/ Extruded	C: 300	Weight loss/ H_2 generation	Closed	Yes	237	(Troutner 1960)

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Table A2 (*continued*)

No.	T (°C)	Reactant water	Material	Thermal treatment /Surface preparation	Impurity content (ppm)	Method	Open/ Closed System	UH_3	Reaction rate ($mgU.cm^{-2}.h^{-1}$)	Reference
180	250	Distilled water and steam (155.1 bar)	Natural U ingot or defected fuel element	α -hot-rolled/ Extruded	C: 300	Weight loss/ H_2 generation	Closed	Yes	249	(Troutner 1960)
181	300	Distilled water and steam (103.4 bar)	Natural U ingot or defected fuel element	α -hot-rolled/ Extruded	C: 300	Weight loss/ H_2 generation	Closed	Yes	619	(Troutner 1960)
182	300	Distilled water and steam (155.1 bar)	Natural U ingot or defected fuel element	α -hot-rolled/ Extruded	C: 300	Weight loss/ H_2 generation	Closed	Yes	724	(Troutner 1960)

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Appendix B. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.jhazmat.2020.122763.

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